CETACEAN AND SEABIRD ASSESSMENT PROGRAM

Submitted to

U. S. Department of Commerce
National Marine Fisheries Service
Northeast Fisheries Center
Woods Hole, Massachusetts 02543

in fullfillment of

NMFS Grant No. 50-EANF-6-00028

by the

Manomet Bird Observatory
Marine Mammal and Seabird Studies
Manomet, Massachusetts o2345

Copies or use of any portion of this report are not allowed without permission of the Manomet Bird Observatory or the National Marine Fisheries Service, Northeast Fisheries Center.

EFFORT EVALUATION OF THE CETACEAN AND SEABIRD ASSESSMENT PROGRAM, 1980-1987

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

The Cetacean and Seabird Assessment Program (CSAP) has been conducted by the Manomet Bird Observatory, through a contract with the Northeast Fisheries Center (NEFC) of the National Marine Fisheries Service (NMFS) since May 1980. This long-term monitoring program is designed to provide an assessment of the abundance and distributions of populations of cetaceans, seabirds and marine turtles in the shelf waters of the northeastern United States.

The CSAP data base has been designed to be fully compatible with NMFS data bases in order to permit the analysis of the trophic interactions among these consumers and their prey. The importance of quantitative, spatial and temporal abundance data on cetaceans and seabirds cannot be overstated. The total estimated consumption of zooplankton, fish and squid on Georges Bank by the cetacean (Scott et al. 1983; Kenney et al. 1985) and seabird (Powers and Backus 1985) communities has been estimated at 7.4 kcal/m2/yr, which is greater than the rate of human use, which has been estimated to be 6.1 kcal/m2/yr (Sissenwine et al. 1983). This underscores the importance of a cetacean/seabird assessment program integrated with standardized fishery surveys.

The design, method of stratification, and timing of the SCAP sampling effort have been completely congruent with those of the NMFS surveys. CSAP was designed to ensure that cetacean and seabird data could be directly compared with fisheries data bases in a statistical manner. Thus far, the CSAP data base has been used to assess: 1) seasonal and spatial distributions and abundance of cetaceans (Payne et al. 1984) and seabirds (Powers 1983, 1987; Powers and Brown 1988), 2) site-specific evaluations of cetacean/seabird distributions and abundance (Powers 1987; Powers and Payne 1983), 3) trophic interactions and prey selectivity of seabirds (Payne et al. 1983; Powers and

Backus 1988) and cetaceans (Payne et al. 1986; Smith et al. 1988), and 4) the relationship between cetacean distributions and oceanographic features (Payne et al. 1986; Selzer and Payne 1988). In addition, the CSAP data base, in combination with other databases, has been used to characterize the distribution of cetaceans and seabirds in relation to nearshore and offshore dumpsites and proposed incineration-at-sea locations.

In a recent examination of the utility of CSAP to meet the needs of NMFS/NEFC (Smith et al. 1988), the need for further analyses of CSAP data, especially those designed to examine the ability of CSAP to monitor long-term spatial and temporal trends in the distribution of cetaceans and seabirds, and those designed to assess the abundance of cetaceans, was recognized. The ability of CSAP to assess the cetacean and seabird communities also need be examined relative to expected decreases in total NMFS survey effort, which may affect the ability of this program to monitor cetacean and seabird distribution and abundance.

To that end, this report provides 1) a discussion of the CSAP effort relative to survey type, and extent of effort by region and season, for 1980-1987, 2) a detailed accounting of the number of sightings per transect of each cetacean species by survey type and season, 3) and a comparative examination of the abundance of cetaceans (sightings per transect) for selected species of cetaceans between the results using the entire database (all NMFS surveys, 1980-1987) with data collected only on MARMAP and on bottom trawl surveys for the same time period. We also provide distributional data for cetaceans based on sightings collected 1980-1986 throughout the study area. In this examination of the survey effort and results only cetacean sightings and effort were considered.

STUDY AREA AND BACKGROUND

The study area consists of all shelf and shelf-edge waters (waters less than 100 fathoms) of the northeastern United States between Cape Hatteras, N. C. and Nova Scotia, Canada. The area is divided into four distinct water types each having their own characteristic features and species assemblages with regards to fish, cetaceans and seabirds. These areas are the Gulf Of Maine, Georges Bank, southern New England waters and the mid-Atlantic Bight. The principal areas of interest are the waters on and adjacent to Georges Bank.

The area has been spatially stratified by NMFS/NEFC (Grosslein 1969) into strata which are separated by depth and latitude (see Figure 1). These strata are combined into ecological units or subregions, and, when combined, comprise each of the four major regions within the study area (see Figure 2).

The study area has been shown to contain important habitats for feeding aggregations of cetaceans. Gulf of Maine waters are extremely important to large whales (Hain et al. 1981; Cetap 1982; Mayo 1982; Payne et al. 1986). Baleen whales are recorded throughout the shelf, but greatest concentrations occur in the southwest Gulf of Maine during spring through fall (Kenney and Winn 1986; Payne et al. 1986). The areas used most by endangered baleen whales were in the southwest Gulf of Maine along the 100m contour within NMFS/NEFC groundfish strata No. 23-27 (see Figure 1). These area include the Great South Channel north along the outside of Cape Cod, over Stellwagon Bank to Jeffreys Ledge and Jeffreys Basin. This Gulf of Maine based distribution is characteristic of finback *Balaenoptera physalus*, humpback *Megaptera novaeangliae* , minke *B. acutorostrata* and right *Eubalaena glacialis* whales. The southern New England and mid-Atlantic regions were not reported in the ten most occupied shelf areas based on shipboard surveys (Payne et al. 1984).

A second important cetacean habitat off the northeast U. S. for large

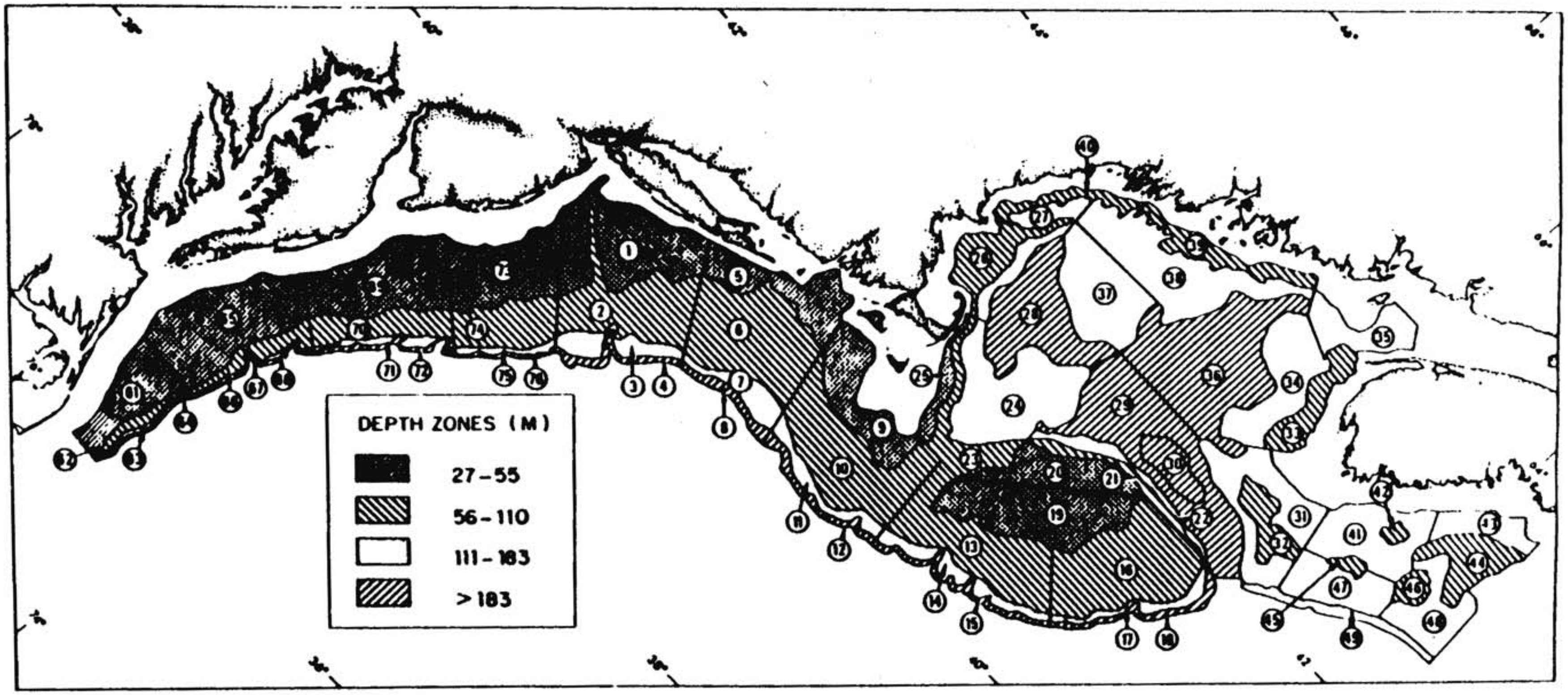


Figure 1. Strata sampled on NEFC offshore bottom trawl surveys.

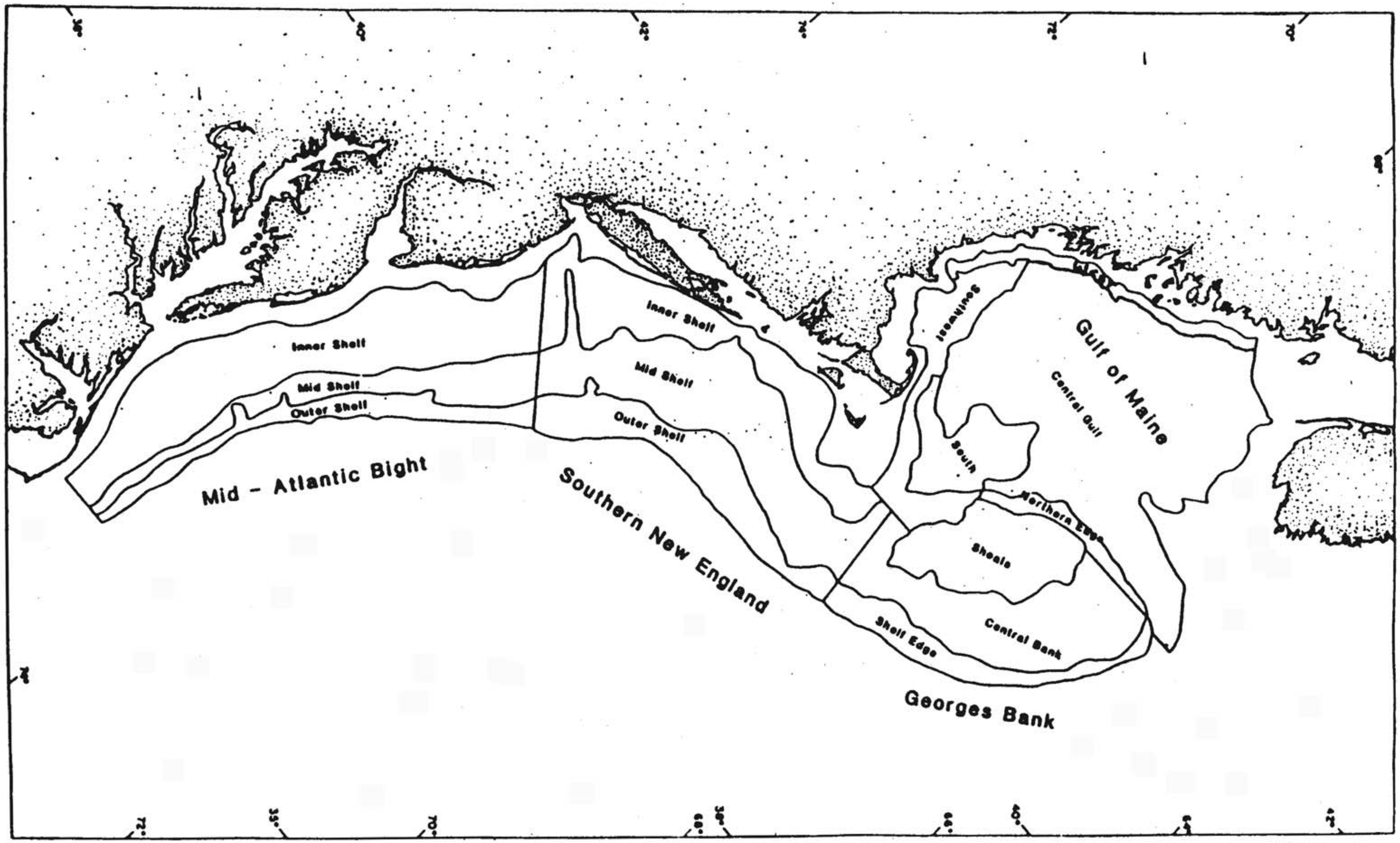


Figure 2. Subregions of the continental shelf of the eastern United States adapted from NMFS/NEFC surveys and mentioned in the text.

cetaceans is along the edge of the continental shelf south and southeast of Georges Bank (Hain et al. 1985; Payne et al. 1984; Kenney et al. 1986, Kenney and Winn 1987). Sperm Whales Physeter macrocephalus, fin whales and sei whales B. borealis were reported in these waters. The only small cetaceans commonly observed with this distribution were the white-sided dolphin Lagenorhynchus acutus and harbor porpoise Phocoena phocoena (Hain et al. 1981; Selzer and Payne 1988).

The greatest concentrations of dolphins occurred from Georges Bank south to the mid-Atlantic regions, principally from mid-shelf seaward to the shelf edge, independent of season (Hain et al. 1981; Cetap 1982; Payne et al. 1986; Selzer and Payne 1988). The species included are common dolphin Delphinus delphis, striped dolphin Stenella coerueoalba, bottlenosed dolphin Tursiops truncatus, grampus Grampus griseus, and pilot whales Globicephala spp. (especially mid-winter). The center of abundance for these species is the mid-Atlantic Bight region although it shifts northward, onto the shelf and into the GOM in summer and fall. Only the southwest GOM was ranked as a high-use habitat for dolphins in that region. This is due to the GOM-based distribution of white-sided dolphins throughout most of the year.

METHODS

NMFS/NEFC Surveys Design-An Overview Relative to CSAP

A long-term series of bottom trawl surveys was begun by NMFS/NEFC in 1963 (Azarovitz 1981). Prior to this, earlier research had focused on a series of unconnected cruises focusing on a few species. The design of the survey was stratified random using depth and latitude as factors in stratification. Initially, 1963-1966, the survey covered the area from Hudson Canyon north to the Scotian Shelf. In 1967 the coverage was extended south to Cape Hatteras. An autumn series has existed since 1963 and a spring groundfish trawl series has existed since 1968. Details on sampling procedures are provided in Grosslein (1969). Because the time-series database generated by this survey was collected with standardized procedures and, therefore, is capable of being analyzed statistically in a consistent manner from survey to survey, season to season and across taxonomic databases (i.e. zooplankton, fish stocks), it has played a key role in the development of a multispecies-ecological approach to fisheries management. The CSAP program was designed to be completely compatible with NMFS/NEFC databases so that marine mammal and seabird data could be compared directly to fishery databases throughout the time series during which both types of information have been gathered.

A basic part of NMFS strategy is to provide a broad-scale monitoring of the ecosystem to provide a database against which predictive models can be evaluated. In 1968, the R/V ALBATROSS IV began taking a plankton tow at each bottom trawl survey station. This piggyback situation continued until 1976 when separate plankton surveys were initiated and NMFS established the Marine Monitoring Assessment and Prediction Program (MARMAP) to provide annual and seasonal monitoring of the distribution, biomass, and population structure of principal biota, and the physical environment on a broad geographical scale (Sherman 1980). In 1980 NMFS/NEFC began placing a dedicated observer on board are MARMAP collected data stored separately?

each MARMAP survey to monitor the distribution and abundance of cetaceans, seabirds and turtles. We consider the Cetacean and Seabird Assessment Program a natural continuation of the MARMAP strategy.

In addition to bottom trawl and plankton surveys, MBO observers are placed on scallop surveys, and other NMFS/NEFC surveys which cover a portion of, or the entire study area, in a stratified design.

Since 1984 all plankton surveys were conducted aboard the R/V DELAWARE II. During 1987 these surveys were discontinued. Groundfish and scallop surveys were conducted aboard the R/V ALBATROSS IV and provided a platform for the dedicated CSAP observer between 1980 -1987.

Cetacean and Seabird Census Techniques

1. Collecting Data at Sea

The cetacean and Seabird Monitoring Program has been designed so that one dedicated observer can collect sighting data on several taxa, principally cetaceans and seabirds (Powers et al. 1980). Observations are recorded from research vessels, principally the NMFS/NEFC research vessels R/V ALBATROSS IV AND R/V DELAWARE II, which conduct standardized surveys throughout the shelf waters of the northeastern United States. Observations are recorded continuously along a predetermined path between NMFS sampling stations as long as the vessel is moving on a straight course and a uniform speed. MBO observers are placed on NMFS/NEFC research vessels on a non-interference basis and cannot determine the course of the vessel during the survey. Therefore the spatial and temporal coverage and the stratified-random component of the Cetacean and Seabird Assessment Program's survey design is dependent entirely on that of the NMFS fishery and zooplankton surveys.

The NMFS stations are randomly placed within each stratum roughly in proportion to the size of each stratum (Grosslein 1969). Therefore the amount of time spent traveling between sampling stations is also proportional to the size of each stratum.

Observations are recorded in 15-minute periods where each period is considered a transect. Thus, the duration of each sampling period is constant but the length of the transect varies slightly depending on vessel speed. Generally all NMFS research vessels operate at speeds between 8-12 knots between sampling stations. Each 15 minute transect is given a unique cruise and observation number. Each 15 minute transect is also placed within a NMFS/NEFC stratum thus enabling all cetacean and seabird sightings within a stratum or combined strata to be directly compared to NMFS zooplankton and trawl survey data for similar strata by cruise, survey, year or by area combined over years.

The data are collected during the day and later transcribed onto coding forms while at sea. Data collected for each 15 minute transect are as follows:

1 CRUISE NUMBER: A numeric code unique to each cruise. The year of the cruise and the number of that cruise within that year are represented in this code.

2 OBSERVATION NUMBER: Unique number for each 15-minute transect within a cruise.

3 OBSERVATION TYPE: Specific census methods differ for seabirds and for cetaceans/turtles. Seabirds are counted in a fixed area, 300m laterally by the distance traveled in a 15 minute transect. A cetacean/turtle census is a count of all observations sighted within 90o of the bow of the ship on either side of the vessel forward of the observer during the 15 minute transect. These censusing methods are used in a specific combination as follows:

Observation Type 1 includes the seabird census and the cetacean/turtle census (i.e. the counts occur concurrently).

Observation Type 2 includes only the cetacean/seabird census.

For first time observers, we suggest that these two separate censusing methods are alternated during the first day or two on the observers first deployment. Therefore the observer spends roughly twice as much time surveying for cetaceans/turtles as for seabirds. An experienced observer conducts only Type 1 observations thereby maximizing available survey time for all taxa. These two survey types are the core of the quantitative database and require that the vessel is moving on a straight course at a constant speed.

Observation Type 3 occurs when a noteworthy sighting (cetacean, large flock of seabirds, rarities or rare occurrence) happens outside the quantitative 15 minute transect period. This is a non-quantitative observation used only for distributional information or rare-occurrence information. The Observation Type 3 occurs under a variety of situations, for example:

.. if an observer is conducting a Type 1 Observation and sees a noteworthy bird or flock of birds outside the 300m counting strip.

.. if the observer is conducting a Type 2 Observation and sees a noteworthy bird sighting anywhere.

.. if the observer is between observations or has just come on watch (i.e. during or just following meals, when ship is stationary, etc.) and sees a noteworthy sighting of any taxa.

.. if the observer sees a cetacean or turtle aft of the previously described cetacean/turtle sighting area at any time.

Observation Type 3 data contributes to distributional analyses but do not contribute to abundance or density estimates.

4 ANIMAL TYPE: Seabirds equal Animal Type 1; Cetaceans equal Animal Type 2; Turtles are Animal Type 3.

5 SPECIES: Each species and species group has their own unique code.

6 NUMBER SEEN: The number of each species observed are recorded for each sighting.

7 AGE: If a seabird can be aged based on differences in plumage, then this is recorded for that sighting. If a group of dolphins has a calf present within the group (or a mother-calf whale sighting), then the calf is noted.

8 SIGHTING ANGLE: Angle relative to the sighting from 0-90o on either side of the bow using the bow of the ship as 0o (for cetaceans and turtles only).

9 DISTANCE TO SIGHTING: Estimated distance (in meters) to cetacean or turtle sighting (for cetacean and turtle sightings only).

10 FEEDING: Behavioral code recorded for all feeding observations of any taxa.

11 DATE: Year-month-day

12 LATITUDE-LONGITUDE: Position of the ship noted for each 15 minute transect. The position is usually recorded at the beginning of each transect.

13 STRATA: The location of each 15 minute transect is also recorded based on NMFS/NEFC bottom trawl survey strata.

14 ELAPSED TIME: The duration of each transect is noted as 15

minutes. Each Observation Type 3 is recorded as zero minutes as an error check to separate quantitative from non-quantitative data.

Sea State
missing

15 SHIP COURSE AND SPEED: Each noted for each transect in whole
16 degrees and to the nearest knot of speed.

17 WATER DEPTH: Recorded in meters.

18 WATER TEMPERATURE: Surface temperature recorded to nearest tenth of a degree Centigrade.

19 WIND SPEED: True wind speed in whole knots.

20 DEBRIS TYPE: Marine debris is recorded on field forms for examination at a later date.

Observers are responsible for collecting data, coding this information and writing a brief narrative of all cetacean/turtle sightings and all noteworthy seabird sightings. Data are collected during daylight hours and coded in the evening at sea. Observers are expected to maximize hours by conducting as many transects and observations as possible during each deployment. Daily operations of the vessel which include meals, sampling stations, and inclement weather provide regular breaks from the routine.

2. Analysis of Census Data

Observations have been traditionally grouped into four seasons: spring (March-May), summer (June-August), fall (September-November), and winter (December-February). Data are spatially divided based on management needs of NMFS/NEFC into four major regions: the Gulf of Maine, Georges Bank, southern New England, and the mid-Atlantic. These regions were adapted from NMFS/NEFC survey strata. Each stratum can be combined with others to form subregions within each major region (i.e. the central Gulf of Maine, or mid-Atlantic Inner Shelf vs. Outer Shelf, etc.).

Estimates of cetacean abundance (for this examination) were derived from the number of individuals /transect. At the initial point of each mammal sighting a radial distance to the sighting from the observer and an angle measurement to the sighting from the transect line are made. Estimating distances at sea are a major source of error in any line transect sampling at sea. Distances up to 1 km are determined with a rangefinder. Sighting distances beyond 1 km are estimated by eye. The use of the ship's radar may be useful in determining distances to objects near the sighting (i.e. ships, buoys) thereby adding greater confidence to the estimated distance. Observers are encouraged to practice estimating distances visually to an object which can be picked up on radar, then verifying their estimate with the actual distance as indicated by the ship's radar. Angles are estimated form the ship's compass on the bridge or flying bridge. Right angle distances are calculated for all sightings from the sighting data.

Estimates of cetacean density are derived from sighting angle and distance data using line transect methodologies (Seber 1973; Eberhardt et al. 1979; Burnham et al. 1980; Scott et al. 1983).

Densities have been estimated using the Cox-Eberhardt (Eberhardt 1978) method. Initial results were presented for the shipboard data in Payne et al. (1984). Using aerial surveys, Cetap (1982), Kenney et al. (1985) and Scott et al. (1983) used this method to estimate densities of cetaceans for the same area. Payne et al. (1984) pooled all dolphin data and all large whale data to determine the decreasing probability of sightings with increased right angle distance from the transect line (i.e. sighting probability function, f(0)).

The theory, mathematics and statistical analysis of transect surveys are well understood (Seber 1973, Eberhardt et al. 1979, Burnham et al. 1980). In general, the probability of sighting an animal on the survey line is assumed to be 100%, and to decrease as a function of the distance from the survey line. In some cases the probability may be 100% out to some distance, d(c), from the survey line, a zone of complete detection, and then decrease. Therefore, if all individuals sighted within some maximum distance d(m) > d(c) are counted, that count will underestimate the actual number of individuals present within a distance d(m) of the survey line; in other words, there will be incomplete detection of the population of individuals that are between distances d(c) and d(m) from the survey line. There are two basic approaches to dealing with the incomplete detection problem. First, line-transect surveys count all individuals observed out to a d(m) that is usually much greater than d(c), often the horizon, and uses information on the distances of the sightings from the transect line to compensated for the negative bias that results from incomplete detection. Second, strip-transect surveys count all individuals observed within some distance from the transect line, d(s) <= d(c).

The different characteristics of marine mammals and seabirds mean that different survey techniques are best suited to each group. Because seabirds often occur in densities too high to allow enough time to estimate all of their distances from the transect line, they are surveyed using a strip-transect in almost all studies (see Tasker et al. 1984). Marine mammals rarely occur at such high densities. In fact, their densities are often so low that sampling to the horizon must be employed to maximize the number of individuals counted and therefore lower the confidence limits on density estimates derived from the data. Therefore, mammals are surveyed with the line-transect technique.

The strip-transect technique currently used by this program was developed after several years of experience with censusing seabirds in the study area, and incorporated theory and field techniques developed in other programs (see descriptions in Powers et al. 1980, Powers 1982, 1983). In practice, the d(s) used in this study, 300 m, is larger than the d(c) for many species. Indeed, often the assumption of complete transect even on the transect line is invalid (Wiens et al. 1978, Tasker et al. 1984). Therefore, most estimates of seabird

15 min blocks

RESULTS

Effort Summary-Number of Transects by Survey Type, Subregion and Season

The number of transects conducted for all years, 1980-1987, by subregion and season are presented in Table 1. A combined total of 18,826 transects were conducted throughout the study area and during the entire time period. The spring through fall total (N=16,393) represents 87% of the total number of transects conducted throughout the year. Within the year, areal and temporal coverage varies significantly between survey type.

1. Bottom Trawl Surveys

Bottom trawl or groundfish surveys occurred primarily during spring and autumn (Table 2). A total of 3,542 transects were conducted during these two seasons. This is 93% of the total number of transects conducted on trawl surveys throughout the year.

2. MARMAP Surveys

MARMAP or ichthyo-and phytoplankton surveys provided the best seasonal and regional coverage of any individual type of survey (Table 3). A total of 4,920 transects were conducted spring through fall, representing 89% of the total for this survey type. This survey type also provided the CSAP program with the largest number of cruises upon which we could place an observer. This is partially because MARMAP operated three surveys per year rather than two for the trawl surveys, and one for the scallop survey. Perhaps more importantly, MARMAP provided CSAP with the best winter coverage throughout the study area. Fifty-five percent of the total number of transects conducted during winter were conducted aboard MARMAP surveys. The remainder of the winter data was collected aboard NMFS non-survey cruises which lack the spatial coverage of the MARMAP surveys. Since MARMAP was significantly reduced during 1988, winter coverage will not be a standard feature of the assessment program in the future.

= 192 h

Table 1. Number of marine mammal transects conducted during all surveys for 1980 through 1987 (transects conducted at wind speeds >16 knots excluded).

REGION	SUB-REGION	SPRING	SUMMER	AUTUMN	WINTER	ANNUAL TOTAL
GULF OF MAINE	WEST	34	33	43	77	137
	CENTRAL GULF	308	498	511	402	1719
	SOUTHWEST	199	562	223	182	1166
	SOUTH	137	173	190	107	607
	REGION TOTAL	678	1266	967	768	3679
GEORGES BANK	NORTHERN EDGE	77	75	113	27	315
	SHOALS	241	294	223	82	840
	CENTRAL BANK	337	684	403	235	1659
	SHELF EDGE	128	140	167	44	479
	REGION TOTAL	783	1214	906	390	3293
SOUTHERN NEW ENGLAND	INNER SHELF	335	725	447	183	1690
	MIDDLE SHELF	550	859	517	259	2185
	OUTER SHELF	292	188	282	50	812
	REGION TOTAL	1177	1772	1246	492	4687
MID-ATLANTIC BIGHT	INNER SHELF	379	869	426	276	2150
	MIDDLE SHELF	307	450	326	106	1189
	OUTER SHELF	188	174	209	65	636
	CAROLINA CAPE	97	23	36	4	160
	REGION TOTAL	1171	1516	997	451	4135
COASTAL ZONE	STRATUM 96	118	208	126	155	607
	STRATUM 95	288	237	326	130	981
	STRATUM 94	132	127	182	33	474
	REGION TOTAL	538	572	634	318	2062
CONT'AL SLOPE	REGION TOTAL	228	426	302	14	970
	ALL REGIONS COMBINED	4575	6766	5052	2433	18826

Table 2. Number of marine mammal transects conducted during bottom trawl surveys for 1980 through 1987 (transects conducted at wind speeds >16 knots excluded).

REGION	SUB-REGION	SPRING	SUMMER	AUTUMN	WINTER	ANNUAL TOTAL
GULF OF MAINE	WEST	33	0	20	0	53
	CENTRAL GULF	244	0	253	0	502
	SOUTHWEST	116	27	112	0	255
	SOUTH	35	1	72	0	108
	REGION TOTAL	428	28	462	0	918
GEORGES BANK	NORTHERN EDGE	34	2	77	0	113
	SHOALS	71	9	86	0	186
	CENTRAL BANK	101	21	174	0	296
	SHELF EDGE	76	0	68	0	144
	REGION TOTAL	302	32	405	0	739
SOUTHERN NEW ENGLAND	INNER SHELF	92	38	116	7	253
	MIDDLE SHELF	169	21	233	13	436
	OUTER SHELF	94	0	168	2	264
	REGION TOTAL	355	59	517	22	953
MID-ATLANTIC BIGHT	INNER SHELF	88	0	119	1	208
	MIDDLE SHELF	51	0	131	34	216
	OUTER SHELF	48	0	124	39	211
	CAROLINA CAPE	11	0	19	0	30
	REGION TOTAL	198	0	393	74	665
COASTAL ZONE	STRATUM 96	81	12	22	8	123
	STRATUM 95	77	9	124	6	216
	STRATUM 94	56	0	95	0	151
	REGION TOTAL	214	21	241	14	490
CONT'AL SLOPE	REGION TOTAL	27	0	0	0	27
	ALL REGIONS COMBINED	1524	140	2013	110	3792

Table 3. Number of marine mammal transects conducted during MARMAP surveys for 1980 through 1987 (transects conducted at wind speeds >16 knots excluded).

REGION	SUB-REGION	SPRING	SUMMER	AUTUMN	WINTER	ANNUAL TOTAL
GULF OF MAINE	WEST	1	7	23	43	74
	CENTRAL GULF	64	81	115	345	635
	SOUTHWEST	54	33	77	93	257
	SOUTH	82	25	33	75	215
	REGION TOTAL	201	146	280	556	1183
GEORGES BANK	NORTHERN EDGE	33	5	9	27	74
	SHOALS	78	23	100	70	271
	CENTRAL BANK	93	40	120	152	405
	SHELF EDGE	6	23	46	39	114
	REGION TOTAL	210	91	275	288	864
SOUTHERN NEW ENGLAND	INNER SHELF	153	58	203	48	462
	MIDDLE SHELF	147	53	187	100	487
	OUTER SHELF	116	27	72	30	245
	REGION TOTAL	416	138	462	178	1194
MID-ATLANTIC BIGHT	INNER SHELF	367	75	231	73	746
	MIDDLE SHELF	179	32	165	46	422
	OUTER SHELF	74	10	62	26	172
	CAROLINA CAPE	63	8	14	0	85
	REGION TOTAL	683	125	472	145	1425
COASTAL ZONE	STRATUM 96	26	12	47	100	185
	STRATUM 95	130	48	118	53	349
	STRATUM 94	33	20	48	15	121
	REGION TOTAL	194	80	213	168	655
CONT'AL SLOPE	REGION TOTAL	118	47	55	6	228
	ALL REGIONS COMBINED	1822	629	1757	1341	5549

3. SCALLOP SURVEYS

Scallop surveys were conducted only during the summer season, primarily in inner- to mid-shelf waters (Table 4). Scallop surveys generally excluded the Gulf of Maine and all outer shelf waters. Thirty-three percent of the total summer coverage throughout the study area occurred on scallop surveys. However, this percentage increased to between 40% and 50% of the summer survey coverage when considering the following regions: Georges Bank, Southern New England and mid-Atlantic.

4. NORTHEAST MONITORING SURVEYS

A total of 2,697 transects, or 14% of the total, were conducted aboard surveys generally considered as Northeast Monitoring Surveys (Table 5). These surveys provided widespread coverage throughout the study area, generally in the summer. Forty-eight percent of the transects conducted on these surveys were conducted during the summer period, representing 20% of the entire number of transects conducted during summer, 1980-1987. Therefore a total of 53% of all transects conducted during summer occurred on either scallop surveys or Northeast Monitoring surveys.

5. NON-NMFS SURVEYS

Twenty-five percent (n=4,523) of the total number of transects in the CSAP data base occurred on cruises which were not conducted by NMFS (Table 6). Most of these non-NMFS surveys were conducted by the Environmental Protection Agency and focused on designated deepwater dumpsites or proposed incineration-at-sea locations. Therefore, most of the survey occurred in slope waters beyond the shelf edge. For example, 46% (n=443) of the total number of transects conducted in slope waters, 1980-1987, occurred on non-NMFS cruises (from Table 6). However, the same sampling design which we use on the standardized NMFS surveys are also used on these surveys. Therefore, transects are conducted through shelf and shelf-edge portions of the study

Table 4. Number of marine mammal transects conducted during scallop surveys for 1980 through 1987 (transects conducted at wind speeds >16 knots excluded.

REGION	SUB-REGION	SUMMER	AUTUMN	ANNUAL TOTAL
GULF OF MAINE	WEST	5	0	5
	CENTRAL GULF	74	0	74
	SOUTHWEST	182	6	188
	SOUTH	16	2	18
	REGION TOTAL	278	8	286
GEORGES BANK	NORTHERN EDGE	32	0	32
	SHOALS	120	0	120
	CENTRAL BANK	335	0	335
	SHELF EDGE	33	0	33
	REGION TOTAL	520	0	520
SOUTHERN NEW ENGLAND	INNER SHELF	343	0	343
	MIDDLE SHELF	410	0	410
	OUTER SHELF	31	0	31
	REGION TOTAL	784	0	784
MID-ATLANTIC BIGHT	INNER SHELF	395	0	395
	MIDDLE SHELF	222	0	222
	OUTER SHELF	10	0	10
	CAROLINA CAPE	5	0	5
	REGION TOTAL	632	0	632
COASTAL ZONE	STRATUM 96	38	0	38
	STRATUM 95	5	0	5
	REGION TOTAL	43	0	43
ALL REGIONS COMBINED		2257	8	2265

Table 5. Number of marine mammal transects conducted during Northeast Monitoring Surveys for 1980 through 1987 (transects conducted at wind speeds >16 knots excluded).

REGION	SUB-REGION	SPRING	SUMMER	AUTUMN	WINTER	ANNUAL TOTAL
GULF OF MAINE	WEST	0	7	0	31	38
	CENTRAL GULF	0	67	0	44	111
	SOUTHWEST	5	56	0	78	139
	SOUTH	6	14	17	25	62
	REGION TOTAL	11	144	17	178	350
GEORGES BANK	NORTHERN EDGE	0	9	5	2	16
	SHOALS	41	63	0	12	116
	CENTRAL BANK	116	103	8	61	288
	SHELF EDGE	29	49	21	4	103
	REGION TOTAL	186	224	34	79	523
SOUTHERN NEW ENGLAND	INNER SHELF	7	106	77	90	280
	MIDDLE SHELF	16	89	46	87	238
	OUTER SHELF	36	59	16	1	112
	REGION TOTAL	59	254	139	178	630
MID-ATLANTIC BIGHT	INNER SHELF	0	135	65	148	348
	MIDDLE SHELF	0	76	19	12	107
	OUTER SHELF	0	51	1	0	52
	CAROLINA CAPE	0	1	0	0	1
	REGION TOTAL	0	263	85	160	508
COASTAL ZONE	STRATUM 96	0	78	18	23	119
	STRATUM 95	0	90	79	45	214
	STRATUM 94	0	48	15	18	81
	REGION TOTAL	0	216	112	86	414
CONT'AL SLOPE	REGION TOTAL	65	191	8	8	272
	ALL REGIONS COMBINED	321	1292	395	689	2697

Table 6. Number of marine mammal transects conducted during non-NMFS surveys for 1980 through 1987 (transects conducted at wind speeds >16 knots excluded.

REGION	SUB-REGION	SPRING	SUMMER	AUTUMN	WINTER	ANNUAL TOTAL
GULF OF MAINE	WEST	0	13	0	3	16
	CENTRAL GULF	0	276	108	13	397
	SOUTHWEST	24	264	26	11	325
	SOUTH	14	117	66	7	204
	REGION TOTAL	38	670	200	34	942
GEORGES BANK	NORTHERN EDGE	10	48	22	0	80
	SHOALS	31	79	37	0	147
	CENTRAL BANK	27	185	101	22	335
	SHELF EDGE	17	35	32	1	85
	REGION TOTAL	85	347	192	23	647
SOUTHERN NEW ENGLAND	INNER SHELF	83	180	51	38	352
	MIDDLE SHELF	218	286	51	59	614
	OUTER SHELF	46	71	26	17	160
	REGION TOTAL	347	537	128	114	1126
MID-ATLANTIC BIGHT	INNER SHELF	124	264	11	54	453
	MIDDLE SHELF	77	120	11	14	222
	OUTER SHELF	66	103	22	0	191
	CAROLINA CAPE	23	9	3	4	39
	REGION TOTAL	290	496	47	72	905
COASTAL ZONE	STRATUM 96	11	68	39	24	142
	STRATUM 95	81	85	5	26	197
	STRATUM 94	38	59	24	0	121
	REGION TOTAL	130	212	68	50	460
CONT'AL SLOPE	REGION TOTAL	18	186	239	0	443
	ALL REGIONS COMBINED	908	2448	874	293	4523

area on the way to slope waters and are incorporated into the assessment database as needed. These surveys are most useful in compiling distributional data for shelf edge and slope waters, but of limited use for assessing cetacean populations in shelf waters.

6. OVERVIEW-SURVEY EFFORT

As a general overview, the best spatial coverage occurred on standardized NMFS MARMAP and bottom trawl surveys (see Figure 3a). However, bottom trawl surveys generally only provided coverage during the spring and fall seasons. Although MARMAP surveys provided the most complete spatial and temporal coverage of any single survey type, they excluded the summer months. The scallop surveys (see Figure 3b) and Northeast Monitoring Surveys (NMFS-miscellaneous) provided the most extensive coverage during the summer period, but ignored the shelf edge regions.

Given the orignal NMFS stratification scheme, the combined data set has many desirable features. The entire data base can be used to examine distributional patterns. Population estimates or assessments, both absolute and relative, can be conducted at the stratum level with the entire database. The simple random sampling within the stratified NMFS survey design allows for a fairly uniform distribution of transects throughout the study area, given the temporal constraints of each survey type. It also allows for examination of any portion of the complete dataset, i.e. by season, survey type, area, etc., a posteriori to the data collection period. Abundance trends or population estimates can be best obtained only from the NMFS standardized surveys. Trophic questions, regarding cetaceans and prey species, can be examined using only the bottom trawl survey data. The deletion of any portion of the data set will compromise its present flexibility. An example of this is the recent NMFS decision to conduct MARMAP surveys only every third year. This will eliminate the only standardized survey during the winter period and

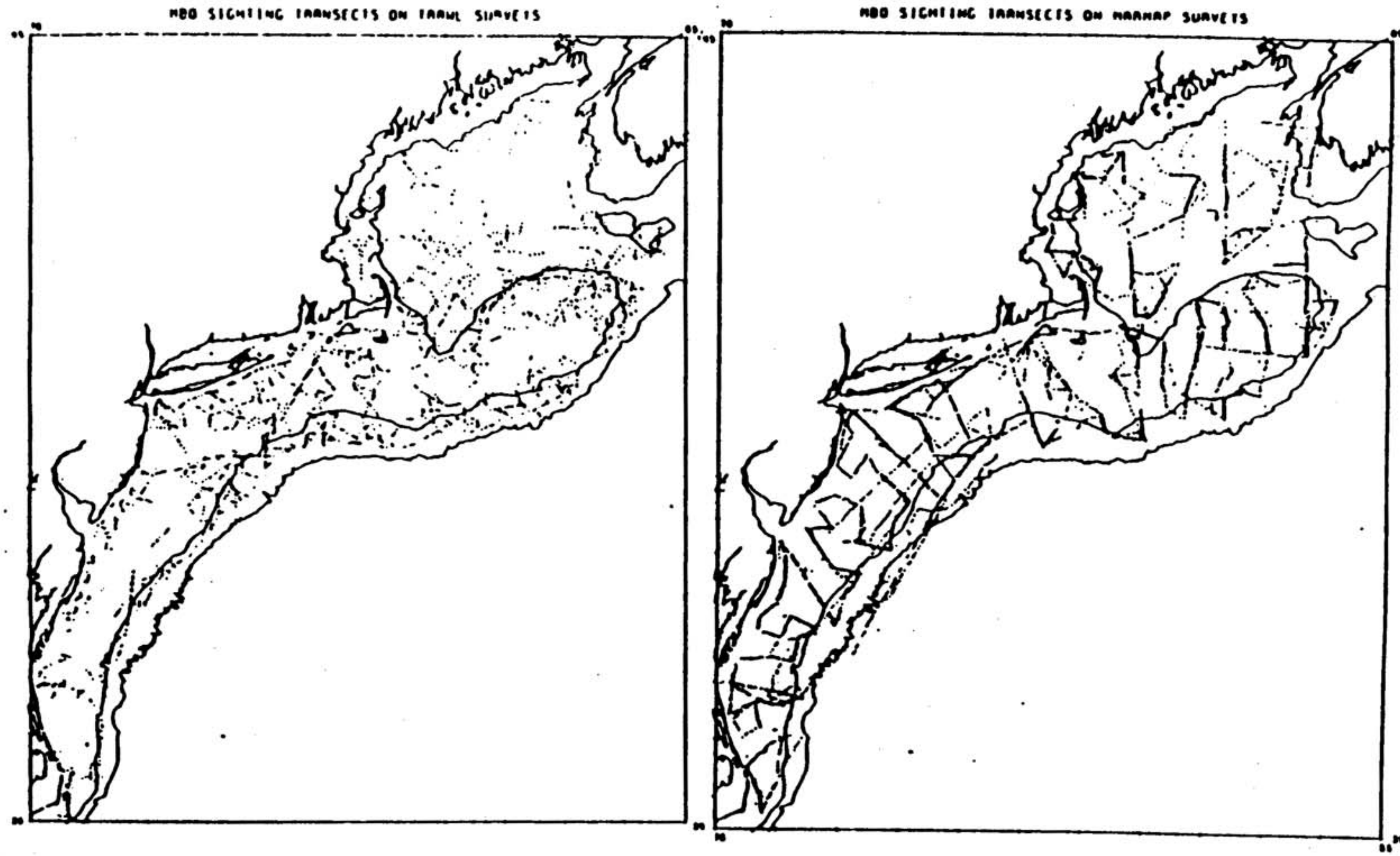


Figure 3a. Location of cetacean and seabird sighting transects sampled during the bottom trawl and MARMAP survey components of the Northeast Fishery Center standardized surveys showing the differences in the distribution of transects with survey type (from Smith et al. 1988).

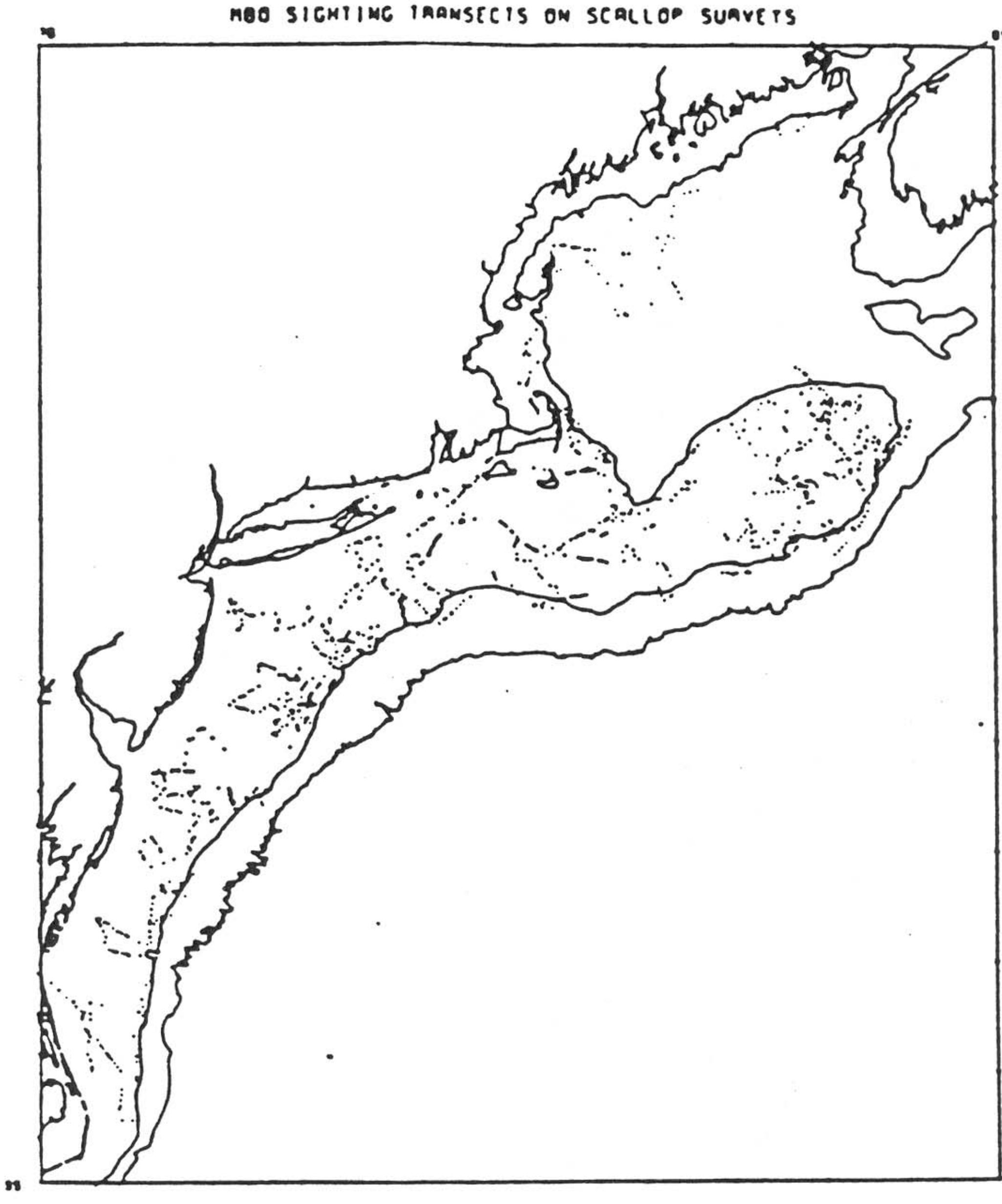


Figure 3b. Location of cetacean and seabird sighting transects sampled during the scallop survey component of the Northeast Fishery Center standardized surveys showing the distribution of transects with this survey type (from Smith et al. 1988).

will, in the future, significantly reduce the total spring and fall effort as well.

Transect data collected at windspeeds up to 20 knots have been used to assess seabird populations. However, Payne et al. (1984) found that sightings of marine mammals and turtles decreased significantly when wind speeds were greater than 16 knots. Therefore, we have only examined transect data for cetaceans and turtles which was conducted at windspeeds less than or equal to 16 knots. Therefore, for each deployment a percentage of the total survey time was lost due to weather conditions. Because observers were instructed to conduct transects during daylight hours (independent of wind speed), we can examine how much time was lost during each survey type by season due to high wind conditions.

Given recent trends in government budget constraints, it is extremely useful to try and determine at what effort level the CSAP can still monitor cetacean distributions. For example, can the monitoring be conducted only during trawl surveys? How much effort is lost due to the recent cutback of the MARMAP survey relative to the number of cetaceans observed and weather conditions during the periods of this survey? Did we really lose any monitoring capability by eliminating winter surveys?

To answer these questions we will first examine the effect of wind speed on the number of transects conducted during each survey type by season to determine what percentage of transects were conducted at wind speeds greater than Beaufort 4 (>16 knots). We will also examine the number of baleen whales and dolphins relative to effort (individuals/per transect) observed by region and survey type for the years 1980-1987 combined. We will examine the percent difference between the observed number of animals/transect using the entire data based, using only MARMAP or bottom trawl survey data, or using the entire data set without one or the other of these two survey types.

Effort Summary-Effect of Wind on the Number of Transects Conducted, by Survey Type, Subregion and Season

1. BOTTOM TRAWL

Thirty-one percent (n=1,695) of transects conducted during trawl surveys during 1980-1987 were conducted during wind speeds greater than 16 knots; therefore not included in cetacean assessments (from Table 7). Therefore approximately seventy percent of the data collected during spring and fall aboard this survey type were useful for assessing marine mammals during those seasons.

2. MARMAP

An extremely high percentage (47%) of the transects conducted aboard MARMAP surveys in the winter were not used in assessing marine mammal populations (from Table 7). Given this high percentage, the MARMAP surveys were the most expensive surveys to operate under this program. Approximately one-half of the amount of shipboard time conducted by observers during the winter season (on this survey type) has not been used in assessing marine mammal populations. Approximately 28% of the surveys conducted spring through fall were not acceptable.

3. SCALLOP

Approximately ninety percent of all transects conducted during scallop surveys were done so at wind speeds <17 knots (from Table 7). This is to be expected of surveys conducted only during July and August of each year.

4. NORTHEAST MONITORING SURVEYS

The number of transects conducted below and above wind speed = 16 knots during Northeast Monitoring surveys were similar to those conducted in MARMAP surveys (from Table 7) and conducted over approximately the same time frame.

5. NON-NMFS SURVEYS

An extremely high percentage of transects (43%) have been conducted

Table 7. Number of marine mammal transects conducted below and above 16 knots wind speed for 1980 through 1987 combined (by survey type).

EASON	WIND SPEED (KNOTS)	SURVEY TYPE: BOTTOM TRAWL NUM.	BOTTOM TRAWL PCT.	MARMAP NUM.	MARMAP PCT.	SCALLOP NUM.	SCALLOP PCT.	NORTHEAST MONITORING NUM.	NORTHEAST MONITORING PCT.	NON-NMFS NUM.	NON-NMFS PCT.	ALL SURVEY TYPES COMBINED NUM.	ALL SURVEY TYPES COMBINED PCT.
PRING	<= 16	1539	65.0	1822	73.2	0	-	321	84.0	908	72.4	4590	70.7
	> 17	829	35.0	666	26.8	0	-	61	16.0	346	27.6	1902	29.3
UMMER	<= 16	140	94.6	629	76.5	2263	89.4	1292	84.2	2467	92.2	6791	88.1
	> 17	8	5.4	193	23.5	269	10.6	242	15.8	208	7.8	920	11.9
UTUMN	<= 16	2028	71.4	1757	71.3	8	100	395	75.7	881	72.7	5069	71.9
	> 17	814	28.6	706	28.7	0	0	127	24.3	331	27.3	1978	28.1
INTER	<= 16	110	71.4	1350	52.8	0	-	689	68.3	293	56.3	2442	57.6
	> 17	44	28.6	1208	47.2	0	-	320	31.7	227	43.7	1799	42.4
NNUAL	<= 16	3817	69.2	5558	66.7	2271	89.4	2697	78.2	4549	80.4	13892	74.1
OTAL	> 17	1695	30.8	2773	33.3	269	10.6	750	21.8	1112	19.6	6599	25.9

during winter at wind speeds >16 knots (Table 7). It is apparent by examining the percentage of transects that have not been used in cetacean assessment due to wind, that any surveys conducted throughout winter months can expect that approximately 40% of the days will be blowing at least 17 knots.

6. OVERVIEW-EFFECT OF WIND ON THE NUMBER OF TRANSECTS BY SEASON AND SURVEY TYPE

Several trends are apparent when examining the amount of data that has been used to date for cetacean assessment purposes, as compared to the total amount of data that has been collected. Because sighting efficiency is low in bad weather, mid-spring through mid-fall is the best time frame for conducting shipboard surveys of cetaceans. Scallop and Northeast Monitoring surveys conducted in the summer provided the greatest percentage of time (relative to total effort) when winds were ≤16 knots. Typically, CSAP observers piggy-back aboard NMFS surveys and do not control the time when surveys are conducted or when the ship moves during these survey periods. In order to ensure proper weather conditions required for shipboard surveys, surveys conducted during winter would have to select windows of good weather and go out for shorter periods of time and more frequently. Alternatively, by having a large amount of effort, we hit some of the windows of good weather. This provides the necessary sighting data but at a greater expense.

Approximately 25% of the time spent at sea during spring and fall, independent of survey type, occurred during periods of bad weather.

MONITORING CAPABILITIES RELATIVE TO LEVELS OF EFFORT-A COMPARISON BETWEEN THE NUMBER OF SIGHTINGS, INDIVIDUALS PER TRANSECT AND THE DISTRIBUTION OF SIGHTINGS FOR THE ENTIRE DATABASE AND FOR SELECTED SURVEY TYPES.

The Number and Distribution of Sightings for the Entire Database

The number of sightings and individual baleen whales observed by region and season are shown in Table 8. The database contains 932 sightings of baleen whales which involved 1,908 individuals. Approximately 56% of all baleen whale sightings occurred in the Gulf of Maine. Seventy-two percent occurred in summer and fall. During spring, baleen whales are also found along mid-shelf to shelf-edge waters in southern New England and along the perimeter of Georges Bank. The spatial distribution of all baleen whales during all seasons, during summer and fall, and during winter and spring, are shown in Figures 4a-4c respectively. Baleen whale concentrations in the mid-Atlantic occur along the shelf edge near Baltimore Canyons, the Hudson Canyon area, Cox' Ledge south to Block Canyon and from Hydrographers Canyon east along the outer edge of Georges Bank. On the shelf, the southwest Gulf of Maine from Jeffreys Ledge to the Great South Channel is the area of the largest baleen whale concentrations.

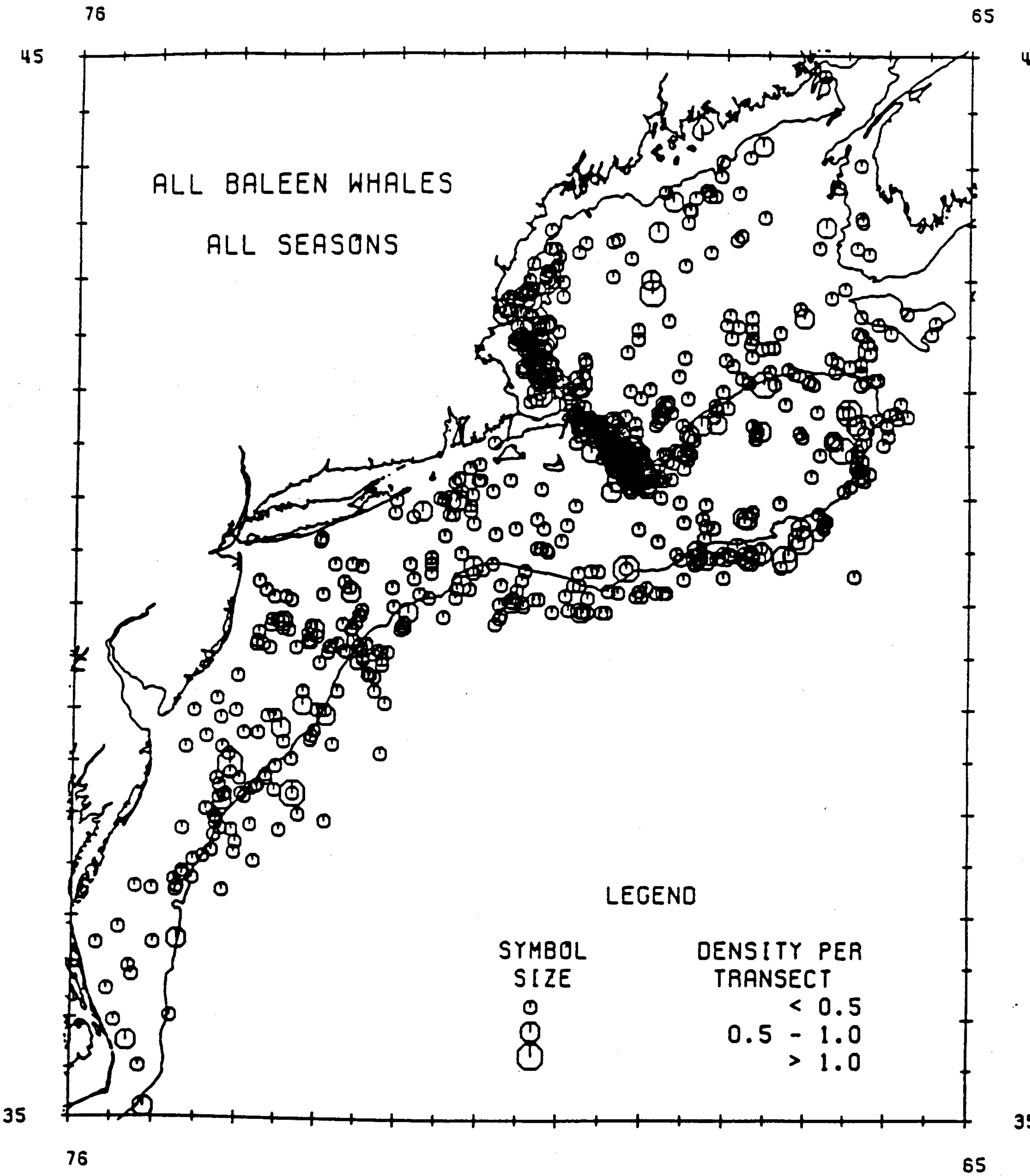
Because effort varied among areas and seasons we show the number of individuals observed per transect in Table 9. The two subregions with most baleen whale sightings per transect include the south (NMFS stratum No. 24) and southwestern Gulf of Maine (NMFS strata Nos. 23, 25-27, Table 10). Therefore, monitoring of large whales could be best achieved during summer and fall, and in the southern portions of the Gulf of Maine, including the western Georges Bank.

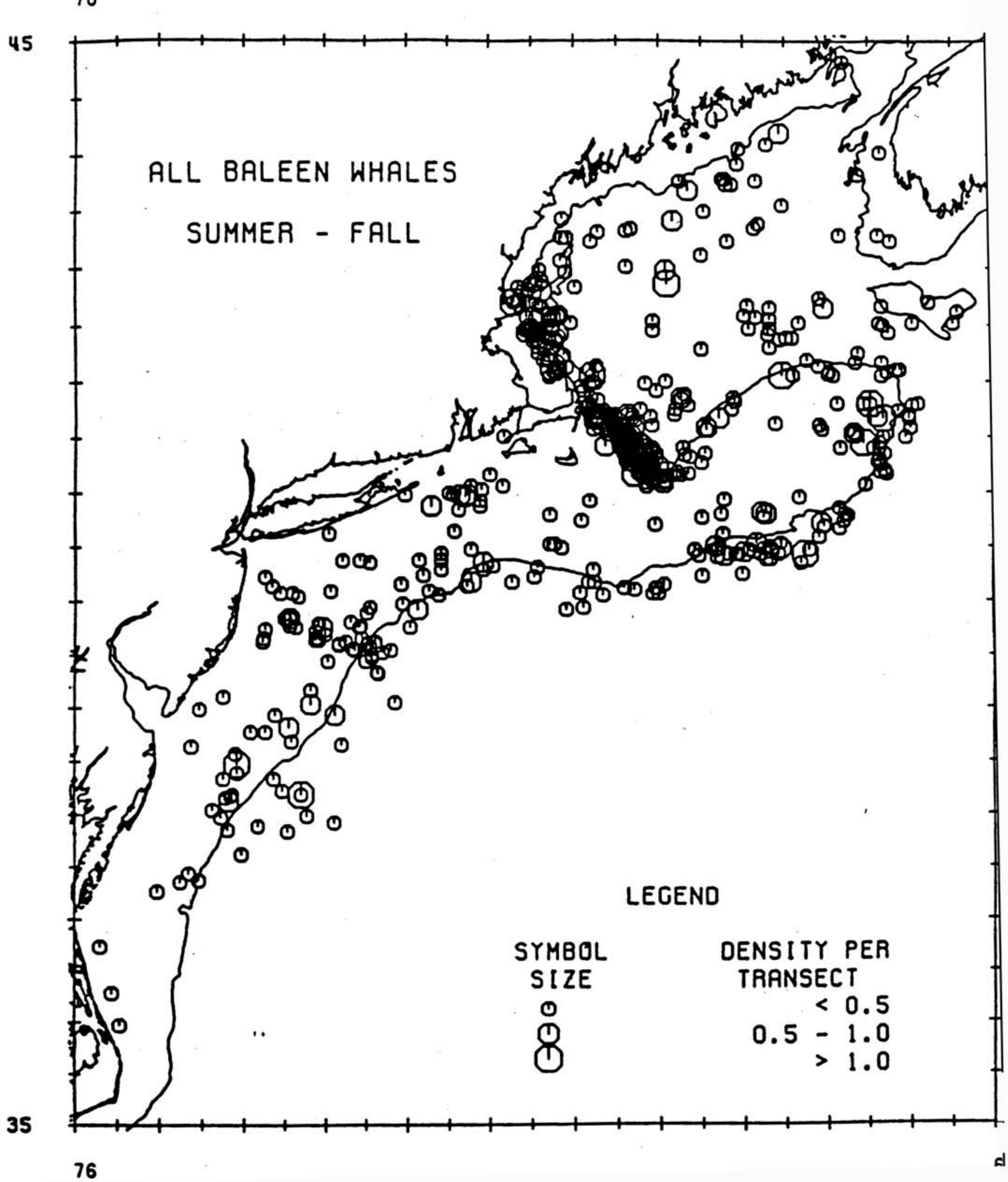
The database also contains 1,109 sightings of dolphins (25,244 individuals, from Table 11). Most sightings occurred spring through fall, in mid-shelf to shelf-edge, and slope regions of the study area (data from Table 11, Figures 5a-5c). The number of dolphins per transect increases from spring

Figure 4a. Distribution of all baleen whale sightings taken during shipboard surveys, for all seasons 1980-1986, in shelf waters of the northeastern United States.

Figure 4b. Distribution of all baleen whale sightings taken during shipboard surveys, for summer and fall 1980-1986, in shelf waters of the northeastern United States.

Figure 4c. Distribution of all baleen whale sightings taken during shipboard surveys, for winter and spring 1980-1986, in shelf waters of the northeastern United States.


76
65
45
45
ALL BALEEN WHALES
ALL SEASONS
LEGEND
SYMBOL SIZE
DENSITY PER TRANSECT
< 0.5
0.5 - 1.0
> 1.0
35
35
76
65


76
45
ALL BALEEN WHALES
SUMMER - FALL
LEGEND
SYMBOL
SIZE
DENSITY PER
TRANSECT
< 0.5
0.5 - 1.0
> 1.0
35
76

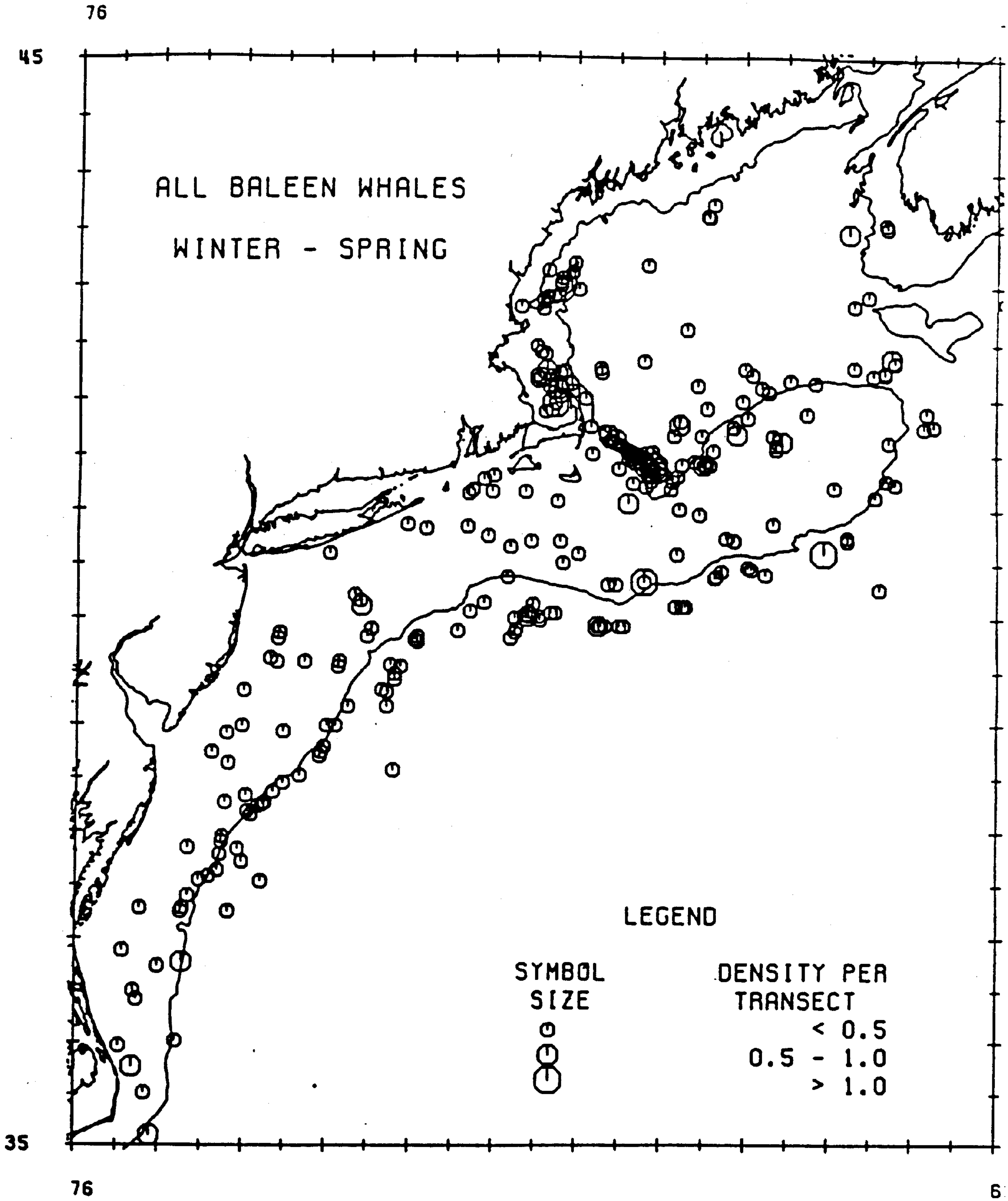

76
45
ALL BALEEN WHALES
WINTER - SPRING
LEGEND
SYMBOL SIZE
DENSITY PER TRANSECT
< 0.5
0.5 - 1.0
> 1.0
35
76
6

Table 8. Number of sightings and individuals of baleen whales from 1980 through 1987 combined by season and subregion.

REGION	SUB-REGION	SPRING SIGHT-INGS	SPRING NUMBERS	SUMMER SIGHT-INGS	SUMMER NUMBERS	AUTUMN SIGHT-INGS	AUTUMN NUMBERS	WINTER SIGHT-INGS	WINTER NUMBERS	ANNUAL TOTA SIGHT-INGS	ANNUAL TOTA NUMBE
	WEST	1	1	3	8	3	4	0	0	7	1
ULF	CENTRAL GULF	5	6	21	30	41	54	9	11	76	10
OF	SOUTHWEST	38	83	194	478	35	99	15	27	282	68
MAINE	SOUTH	27	70	50	97	16	96	3	3	96	26
	REGION TOTAL	71	160	268	613	95	253	27	41	461	106
	NORTHERN EDGE	7	13	16	42	7	8	1	1	31	6
EORGES	SHOALS	7	8	6	8	7	11	0	0	20	2
BANK	CENTRAL BANK	7	11	46	97	19	33	4	4	76	14
	SHELF EDGE	9	11	4	10	30	53	2	2	45	7
	REGION TOTAL	30	43	72	157	63	105	7	7	172	31
OUTHERN	INNER SHELF	6	7	28	54	4	5	2	2	40	6
NEW	MIDDLE SHELF	31	42	32	101	12	16	1	1	76	16
ENGLAND	OUTER SHELF	30	41	12	24	11	12	0	0	53	7
	REGION TOTAL	67	90	72	179	27	33	3	3	169	30
	INNER SHELF	14	21	12	29	2	2	4	6	32	5
ID-	MIDDLE SHELF	11	14	11	27	4	11	2	2	28	5
ATLANTIC	OUTER SHELF	11	14	1	4	3	3	2	2	17	2
BIGHT	CAROLINA CAPE	0	0	2	5	0	0	0	0	2	
		36	49	26	65	9	16	8	10	79	14
	STRATUM 96	3	3	17	24	2	2	4	9	26	3
OASTAL	STRATUM 95	1	1	3	4	0	0	1	2	5	
ZONE	STRATUM 94	1	2	1	1	1	1	0	0	3	
	REGION TOTAL	5	6	21	29	3	3	5	11	34	4
LOPE	REGION TOTAL	5	7	10	24	2	4	0	0	17	3
	ALL REGIONS COMBINED	214	355	469	1067	199	414	50	72	932	190

Table 9. Number of baleen whales per 100 transects for 1980 through 1987 combined by season and subregion.

REGION	SUB-REGION	SEASON: SPRING	SUMMER	AUTUMN	WINTER	ANNUAL TOTAL
	WEST	2.9	24.2	9.3	0.0	9.1
GULF	CENTRAL GULF	1.9	6.0	10.6	2.7	5.3
OF	SOUTHWEST	41.7	85.1	44.4	14.8	46.5
MAINE	SOUTH	51.1	56.1	50.5	2.8	40.1
	REGION TOTAL	24.4	42.8	28.7	5.1	25.3
	NORTHERN EDGE	16.9	43.8	7.1	3.4	17.8
GEORGES	SHOALS	3.3	2.7	4.9	0.0	2.7
BANK	CENTRAL BANK	3.3	14.2	8.2	1.7	6.8
	SHELF EDGE	8.6	7.1	31.7	4.5	13.0
	REGION TOTAL	8.0	16.9	13.0	2.4	10.1
SOUTHERN	INNER SHELF	2.1	7.4	1.1	1.1	2.9
NEW	MIDDLE SHELF	7.6	11.8	3.1	0.4	5.7
ENGLAND	OUTER SHELF	14.0	12.8	4.3	0.0	7.8
	REGION TOTAL	7.9	10.7	2.8	0.5	5.5
	INNER SHELF	3.6	3.3	0.5	2.2	2.4
MID-	MIDDLE SHELF	4.6	6.0	3.4	1.9	4.0
ATLANTIC	OUTER SHELF	7.4	2.3	1.4	3.1	3.6
BIGHT	CAROLINA CAPE	0.0	21.7	0.0	0.0	5.4
	REGION TOTAL	3.9	8.3	1.3	1.8	3.8
	STRATUM 96	2.5	11.5	1.6	5.8	5.4
COASTAL	STRATUM 95	0.3	1.7	0.0	1.5	0.9
ZONE	STRATUM 94	1.5	0.8	0.5	0.0	0.7
	REGION TOTAL	1.5	4.7	0.7	2.4	2.3
SLOPE	REGION TOTAL	3.1	5.6	1.3	0.0	2.5
ALL REGIONS COMBINED		9.3	17.1	9.7	2.4	9.6

Table 10. THE TEN SUBREGIONS WITH THE HIGHEST DENSITY (NUMBER/TRANSECT) OF BALEEN WHALES IN THE STUDY AREA, 1980-1987, BY SEASON AND SUBREGION.

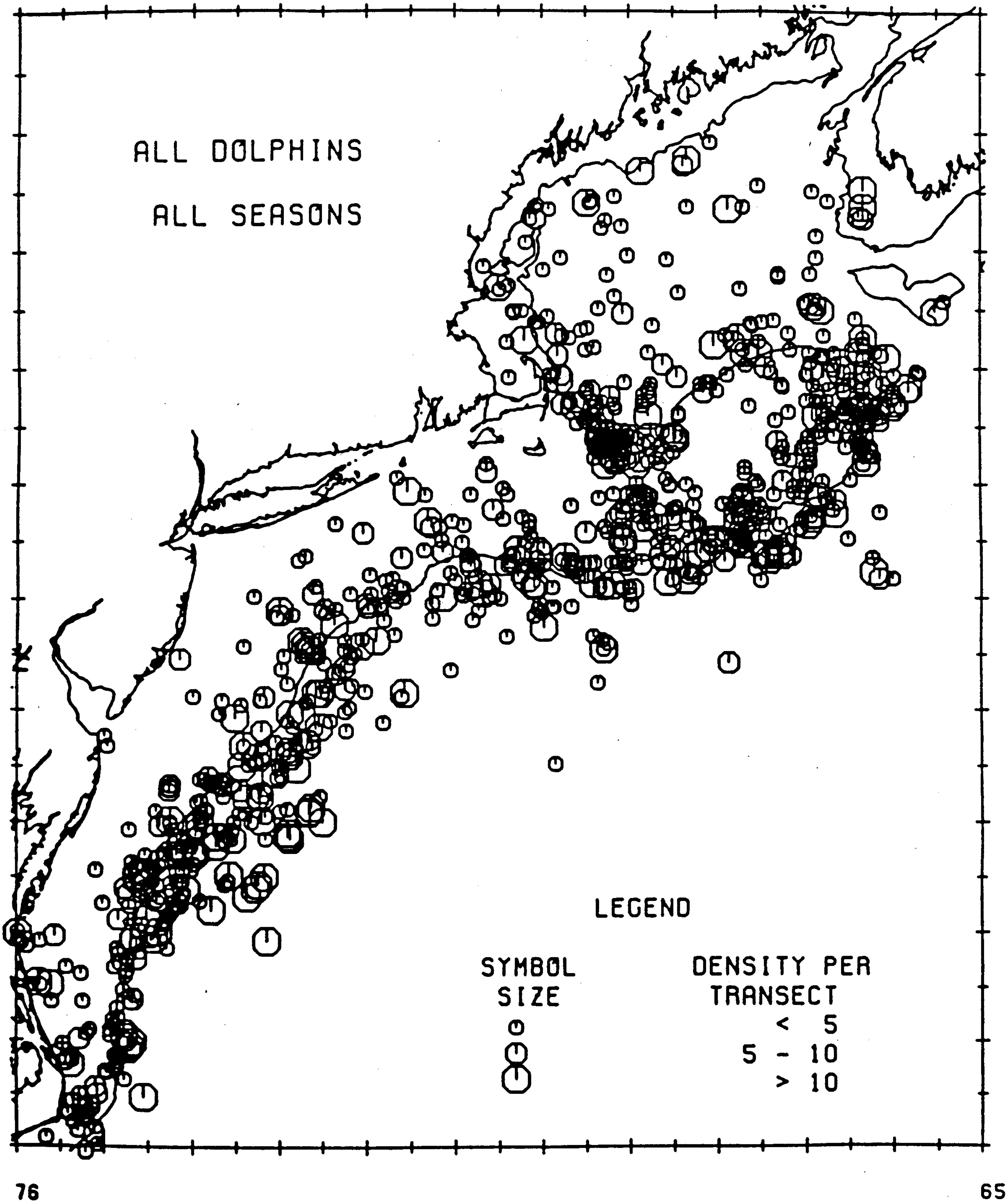
REGION	SEASON	NUMBER/TRANSECT
GOM-southwest	Summer	0.85
GOM-South	Summer	0.56
GOM-South	Spring	0.51
GOM-South	Autumn	0.51
GOM-Southwest	Autumn	0.44
GB-northern Edge	Summer	0.44
GOM-Southwest	Spring	0.42
GB-shelf edge	Autumn	0.32
GOM-west	Summer	0.24
MAB-Carolina Cape	Summer	0.22

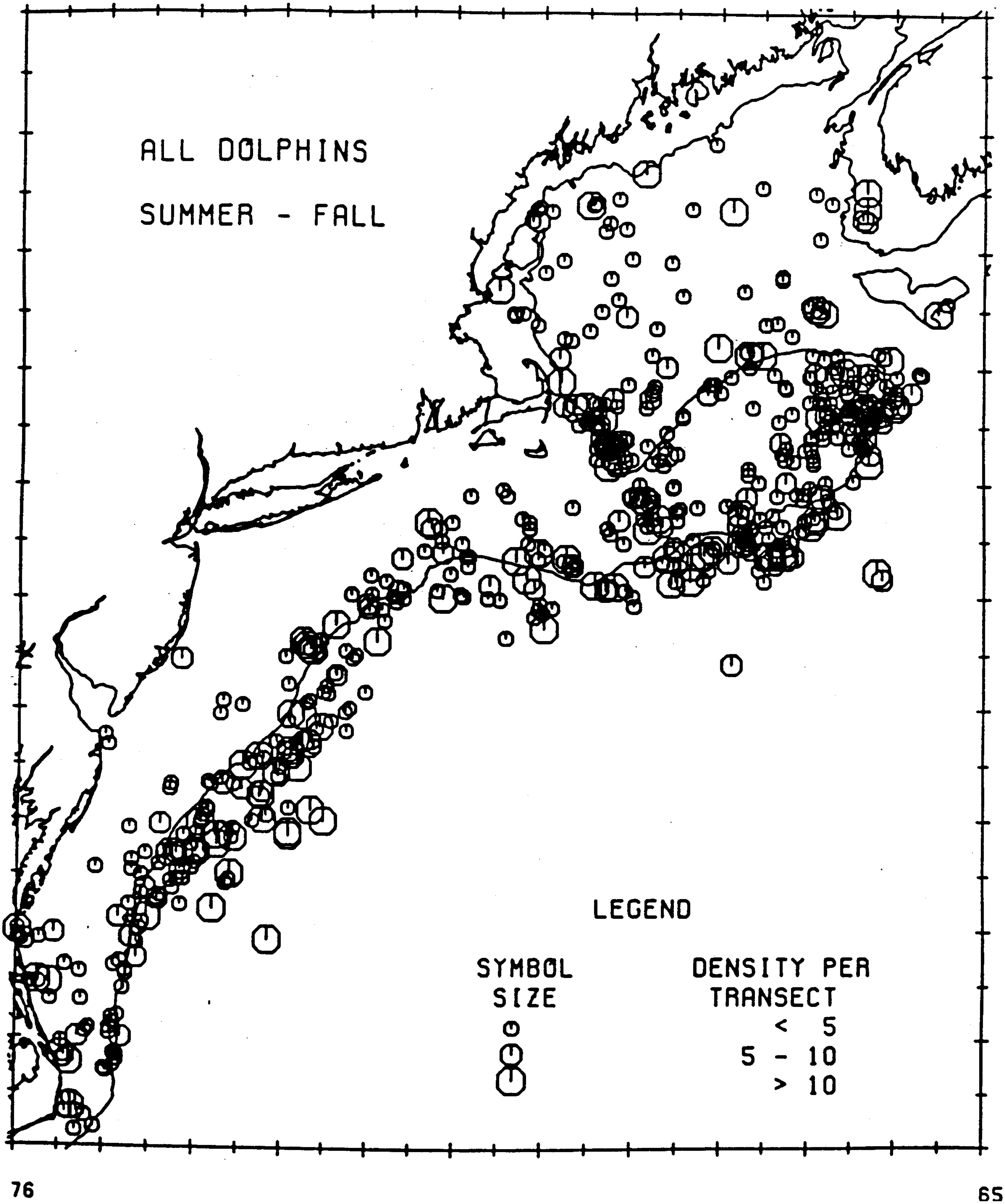
through fall before decreasing to a low during winter (Table 12) with largest concentrations on Georges Bank (Table 13). The perimeter and central portions of Georges Bank are extremely important to dolphins. The Gulf of Maine is not as important to the entire dolphin community as it is to the baleen whale community (from Table 13).

Figure 5a. Distribution of all dolphin sightings taken during shipboard surveys, for all seasons 1980-1986, in shelf waters of the northeastern United States.

Figure 5b. Distribution of all dolphin sightings taken during shipboard surveys, for summer and fall 1980-1986, in shelf waters of the northeastern United States.

Figure 5c. Distribution of all dolphin sightings taken during shipboard surveys, for spring and winter 1980-1986, in shelf waters of the northeastern United States.


ALL DOLPHINS
ALL SEASONS
LEGEND
SYMBOL SIZE
DENSITY PER TRANSECT
< 5
5 - 10
> 10
76
65


ALL DOLPHINS
SUMMER - FALL
LEGEND
SYMBOL SIZE
DENSITY PER TRANSECT
< 5
5 - 10
> 10
76
65

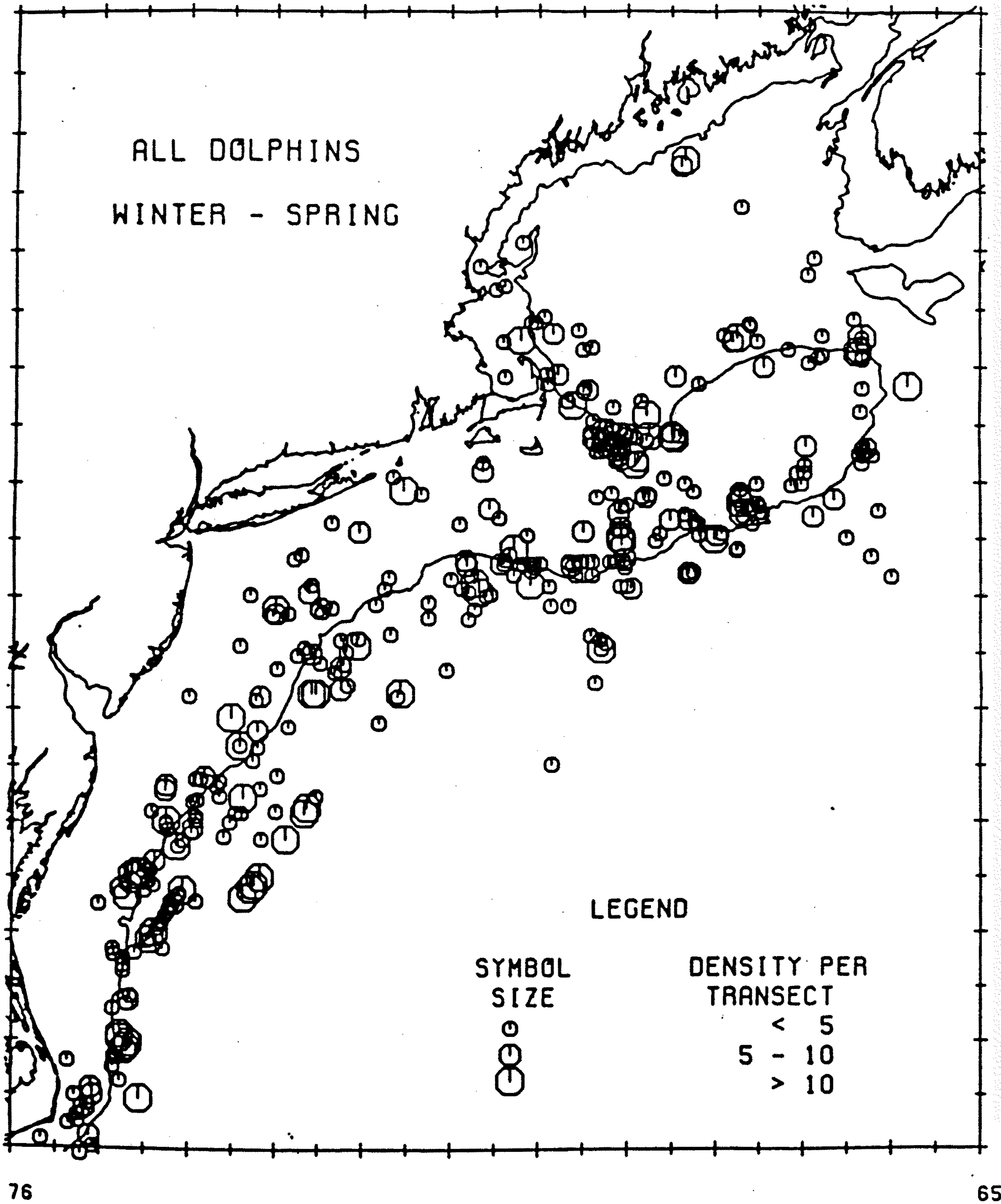

ALL DOLPHINS
WINTER - SPRING
LEGEND
SYMBOL SIZE
DENSITY PER TRANSECT
< 5
5 - 10
> 10
76
65

Table 11. The number of sightings and individuals of delphinids for 1980 through 1987 combined by season and subregion.

		SPRING		SUMMER		AUTUMN		WINTER		ANNUAL TOTAL	
:GION	SUB-REGION	SIGHT-INGS	NUMBERS	SIGHT-INGS	NUMBERS	SIGHT-INGS	NUMBERS	SIGHT-INGS	NUMBERS	SIGHT-INGS	NUMBER
.F	CENTRAL GULF	8	92	14	205	29	405	6	104	57	806
:	SOUTHWEST	15	401	34	498	17	259	9	66	75	1224
IAINE	SOUTH	22	471	14	243	17	162	3	155	56	1031
	REGION TOTAL	45	964	62	946	63	826	18	325	188	3061
	NORTHERN EDGE	5	93	31	819	10	263	3	85	49	1260
IRGES	SHOALS	2	7	16	180	9	40	1	7	28	234
INK	CENTRAL BANK	16	125	111	1951	59	4005	15	254	201	6335
	SHELF EDGE	4	102	20	550	25	1735	5	100	54	2487
	REGION TOTAL	27	327	178	3500	103	6043	24	446	332	10316
ITHERN	INNER SHELF	11	112	5	79	5	42	6	104	27	337
:W	MIDDLE SHELF	39	365	35	649	30	763	35	503	139	2280
:NGLAND	OUTER SHELF	25	399	15	249	19	256	4	33	63	937
	REGION TOTAL	75	876	55	977	54	1061	45	640	229	3554
	INNER SHELF	8	124	30	246	2	10	4	52	44	432
)-	MIDDLE SHELF	22	690	20	378	7	83	11	293	60	1444
'LANTIC	OUTER SHELF	16	343	30	609	23	690	5	30	74	1672
IIGHT	CAROLINA CAPE	9	122	1	4	1	1	0	0	11	127
	REGION TOTAL	55	1279	81	1237	33	784	20	375	189	3675
	STRATUM 96	1	6	2	32	1	100	6	31	10	169
ISTAL	STRATUM 95	0	0	1	20	0	0	0	0	1	20
INE	STRATUM 94	6	37	9	48	14	464	0	0	29	549
	REGION TOTAL	7	43	12	100	15	564	6	31	40	738
IPE	REGION TOTAL	61	1755	51	1486	19	659	0	0	131	3900
	ALL REGIONS COMBINED	270	5244	439	8246	287	9937	113	1817	1109	25244

Table 12. The number of delphinids per 100 transects for 1980 through 1987 combined by season and subregion.

REGION	SUB-REGION	SEASON SPRING	SUMMER	AUTUMN	WINTER	ANNUAL TOTAL
GULF	CENTRAL GULF	29.9	41.2	79.3	25.9	44.0
OF	SOUTHWEST	201.5	88.6	116.1	36.3	110.6
MAINE	SOUTH	343.8	140.5	85.3	144.9	178.6
	REGION TOTAL	143.8	67.6	70.2	51.7	83.3
	NORTHERN EDGE	120.8	853.1	232.7	293.1	374.9
GEORGES	SHOALS	2.9	61.2	17.9	8.5	22.7
BANK	CENTRAL BANK	37.1	285.2	993.8	108.1	356.1
	SHELF EDGE	79.7	392.9	1038.9	227.3	434.7
	REGION TOTAL	60.1	398.1	570.8	159.2	297.1
SOUTHERN	INNER SHELF	33.4	10.9	9.4	56.8	27.6
NEW	MIDDLE SHELF	66.4	75.6	147.6	194.2	120.9
ENGLAND	OUTER SHELF	136.6	132.4	90.8	66.0	106.5
	REGION TOTAL	78.8	73.0	82.6	105.7	85.0
MID-	INNER SHELF	21.4	28.3	2.3	18.8	17.7
ATLANTIC	MIDDLE SHELF	224.8	84.0	25.5	276.4	152.7
BIGHT	OUTER SHELF	182.4	350.0	330.1	46.2	227.2
	CAROLINA CAPE	125.8	17.4	2.8	0.0	36.5
	REGION TOTAL	138.6	119.9	90.2	85.4	108.5
	STRATUM 96	5.1	15.4	79.4	20.0	30.0
COASTAL	STRATUM 95	0.0	8.4	0.0	0.0	2.1
ZONE	STRATUM 94	28.0	37.8	254.9	0.0	80.2
	REGION TOTAL	11.0	20.5	111.4	6.7	37.4
SLOPE	REGION TOTAL	769.7	348.8	218.2	0.0	334.2
ALL REGIONS COMBINED		126.8	156.4	196.1	80.1	139.8

Table 13. THE TEN SUBREGIONS WITH THE HIGHEST DENSITY (NUMBER/TRANSECT) OF BALEEN WHALES IN THE STUDY AREA, 1980-1987, BY SEASON AND SUBREGION.

REGION	SEASON	NUMBER/TRANSECT
GOM-southwest	Summer	0.85
GOM-South	Summer	0.56
GOM-South	Spring	0.51
GOM-South	Autumn	0.51
GOM-Southwest	Autumn	0.44
GB-northern Edge	Summer	0.44
GOM-Southwest	Spring	0.42
GB-shelf edge	Autumn	0.32
GOM-west	Summer	0.24
MAB-Carolina Cape	Summer	0.22

The Number of Sightings and Number per Transect for Selected Survey Types

In the likely event of survey cutbacks, we have tried to simulate a reduction in total observer time by examining only those data collected on MARMAP surveys and those data collected only on trawl surveys. We compared the results of each survey type to the results of the entire database (using only the NMFS surveys in the database). If CSAP observations were reduced to only bottom trawl surveys, a 75% reduction in survey effort would result. Even though we can expect the numbers per transect to change, it would be useful to determine whether areas of high cetacean use are indicated throughout the database and do not vary depending upon survey type.

1. MONITORING CAPABILITIES USING ONLY DATA COLLECTED ON MARMAP AND BOTTOM TRAWL SURVEYS-BALEEN WHALES.

Both the MARMAP and bottom trawl surveys have distinct similarities in their ability to monitor areas of high-use with regards to baleen whales (Table 14). Baleen whales were most abundant in Gulf of Maine-Georges Bank waters in both survey types. The major difference is that trawl surveys picked up areas of abundance from spring through fall, whereas the MARMAP surveys had major concentrations summer and fall only. This is likely due to the timing of MARMAP surveys (early spring) as compared to the timing of trawl surveys which immediately follow MARMAP in the season (late spring). Both survey types tended to show high concentrations (numbers per transect) within the south and southwest subregions of the Gulf of Maine (Tables 15 and 16).

2. PERCENT DIFFERENCES BETWEEN THE NUMBER OF CETACEANS/TRANSECT FOR THE ENTIRE DATABASE AND FOR SELECTED SURVEY TYPES -BALEEN WHALES.

To determine the effect of a greater than 50% reduction in survey effort we examined the percent difference between the abundance (number per transect) of cetaceans (all baleen whales and all dolphins) obtained for each season using only MARMAP or trawl survey data, as compared to the results we obtained using the entire NMFS database.

Table 14. Number of baleen whales per 100 transects in bottom trawl, MARMAP, and all NMFS surveys for 1980 through 1987 combined.

REGION	SUB-REGION	SPRING			SUMMER			AUTUMN			WINTER			ANNUAL TOTAL		
		BOTTOM	MARMAP	NMFS	BOTTOM	MARMAP	NMFS	BOTTOM	MARMAP	NMFS	BOTTOM	MARMAP	NMFS	BOTTOM	MARMAP	NMFS
	WEST	3.0	0.0	2.9	-	0.0	30.0	15.0	4.3	9.3	-	0.0	0.0	9.0	1.1	10.6
GULF	CENTRAL GULF	1.6	3.1	1.9	-	6.2	10.4	11.2	9.7	10.7	-	3.2	2.8	6.4	5.5	6.5
OF	SOUTHWEST	26.7	64.8	44.6	59.3	12.1	69.8	75.0	12.7	47.7	-	2.2	15.8	53.7	22.9	44.5
MAINE	SOUTH	0.0	74.4	50.4	0.0	68.0	48.2	8.3	242.4	71.0	-	2.7	3.0	2.8	96.9	43.1
	REGION TOTAL	7.8	35.6	25.0	29.6	21.6	39.6	27.4	67.3	34.7	-	2.0	5.4	20.0	31.6	26.2
	N. EDGE	5.9	15.2	10.4	0.0	60.0	6.3	5.2	22.2	6.6	-	3.7	3.4	3.7	25.3	6.7
GEORGES	SHOALS	3.3	5.1	3.3	0.0	0.0	1.9	3.5	8.0	5.9	-	0.0	0.0	2.3	3.3	2.8
BANK	CENTRAL BANK	6.9	1.1	2.9	0.0	5.0	8.0	12.1	8.3	10.6	-	2.6	1.9	6.3	4.3	5.8
	SHELF EDGE	13.2	0.0	9.0	-	4.3	9.5	55.9	8.7	34.1	-	5.1	4.7	34.5	4.5	14.3
	REGION TOTAL	7.3	5.3	6.4	0.0	17.3	6.4	19.2	11.8	14.3	-	2.9	2.5	9.6	9.3	7.4
SOUTHERN	INNER SHELF	2.2	0.7	1.2	7.9	1.7	8.1	1.7	1.0	1.0	0.0	0.0	0.7	2.9	0.8	2.7
NEW	MIDDLE SHELF	6.5	10.2	7.8	0.0	17.0	6.5	0.4	4.8	2.4	0.0	0.0	0.5	1.7	8.0	4.3
ENGLAND	OUTER SHELF	26.6	4.3	13.0	-	0.0	2.6	3.0	5.6	3.9	0.0	0.0	0.0	9.9	2.5	4.9
	REGION TOTAL	11.8	5.1	7.3	3.9	6.2	5.7	1.7	3.8	2.4	0.0	0.0	0.4	4.4	3.8	4.0
	INNER SHELF	5.7	4.4	4.6	-	1.3	4.3	0.0	0.9	0.5	0.0	0.0	0.9	1.9	1.6	2.6
MID-	MIDDLE SHELF	11.8	3.9	5.7	-	0.0	5.8	1.5	2.4	3.5	0.0	2.2	2.2	4.4	2.1	4.3
ATLANTIC	OUTER SHELF	8.3	1.4	4.1	-	0.0	5.6	0.8	1.6	1.1	5.1	0.0	3.1	4.8	0.7	3.5
BIGHT	CAPE	0.0	0.0	0.0	-	0.0	35.7	0.0	0.0	0.0	-	-	-	0.0	0.0	11.9
	REGION TOTAL	6.4	2.4	3.6	-	0.3	12.9	0.6	1.2	1.3	1.7	0.7	2.1	3.0	1.2	5.1
	STRATUM 96	2.5	0.0	1.9	25.0	0.0	10.0	4.5	2.1	2.3	0.0	9.0	6.9	8.0	2.8	5.3
COASTAL	STRATUM 95	0.0	0.8	0.5	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.8
ZONE	STRATUM 94	3.6	0.0	2.1	-	0.0	1.5	1.1	0.0	0.6	-	0.0	0.0	2.3	0.0	1.1
	REGION TOTAL	2.0	0.3	1.5	12.5	0.0	4.7	1.9	0.7	1.0	0.0	3.0	2.3	3.7	1.0	2.4
SLOPE	REGION TOTAL	11.1	2.5	3.3	-	0.0	1.3	-	0.0	0.0	-	0.0	0.0	11.1	0.6	1.1
ALL REGIONS COMBINED		7.3	10.1	8.9	10.2	19.2	14.1	11.1	17.6	11.1	0.6	1.7	2.5	8.1	9.8	9.3

Table 15. THE TEN SUBREGIONS WITH THE HIGHEST DENSITY (NUMBER/TRANSECT) OF BALEEN WHALES IN THE STUDY AREA, 1980-1987, BY SEASON AND SUBREGION (DATA FROM MARMAP SURVEYS ONLY).

REGION	SEASON	NUMBER/TRANSECT
GOM-south	Autumn	2.42
GOM-South	Spring	0.74
GOM-South	Summer	0.68
GOM-Southwest	Spring	0.65
GB-northern edge	Summer	0.60
GB-northern Edge	Autumn	0.22
SNE-midshelf	Summer	0.17
GB-northern edge	Spring	0.15
GOM-southwest	Autumn	0.13
GOM-southwest	Summer	0.12

Table 16. THE TEN SUBREGIONS WITH THE HIGHEST DENSITY (ANIMALS/TRANSECT) OF BALEEN WHALES IN THE STUDY AREA, 1980-1987, BY SEASON AND SUBREGION (DATA FROM TRAWL SURVEYS ONLY).

REGION	SEASON	NUMBER/TRANSECT
GOM-southwest	Autumn	0.75
GOM-southwest	Summer	0.59
GB-southern edge	Autumn	0.57
GOM-southwest	Spring	0.27
SNE-outershelf	Spring	0.27
GOM-coastal	Summer	0.25
GOM-west	Autumn	0.15
GB-southern edge	Spring	0.13
GB-central	Autumn	0.12
MAB-midshelf	Spring	0.12

With regards to baleen whales, the estimates tend to be higher during seasons in which the MARMAP surveys occurred, i.e. during spring and autumn (Table 17). Estimates tend to be over 50% higher in the autumn. Most sightings during summer occurred during the scallop or Northeast monitoring surveys; therefore the number of baleen whales per transect for only MARMAP data is less than for the average of the entire database. Most winter effort occurred during MARMAP surveys (55%), however, fewer baleen whales per transect were observed on MARMAP surveys versus other NMFS surveys conducted at that time.

Baleen whales were continually underestimated (as compared to the database average), except in autumn, on bottom trawl surveys. Baleen whales were seen less frequently on bottom trawl surveys throughout the year independent of seasonal effort. There was no significant difference between the number of whales per transect for trawl data only, as compared to the average for the entire database, only in the autumn. Otherwise, the results of the trawl survey were less than the average for the entire database.

3. MONITORING CAPABILITIES USING ONLY DATA COLLECTED ON MARMAP AND BOTTOM TRAWL SURVEYS-DELPHINIDS.

The timing of the MARMAP surveys relative to the trawl surveys, and the fact that MARMAP surveys tended to go into deeper, slope waters was evident when examining timing and location of dolphin sightings per transect (Table 18). Five of the high-density subregions (for dolphins, from Table 19) indicated by MARMAP surveys occurred in spring, or were in the southern New England-mid Atlantic regions of the study area. Eight of the high-density subregions indicated by trawl surveys (Table 20) occurred in summer or fall, and six were either Gulf of Maine or Georges Bank subregions. The largest concentrations of dolphins (based on MARMAP surveys) were midshelf to slope waters (from Table 19). Trawl surveys did not extend into slope waters.

Table 17. Percent difference between the number of baleen whales per transect for MARMAP (upper) or for bottom trawl (lower) surveys, and for all NMFS surveys for 1980 through 1987 combined.

	SPRING	SUMMER	AUTUMN	WINTER	TOTAL
Coastal	-80.0	-	-30.0	+30.0	-58.3
Gulf of Maine	+42.4	+54.5	+93.9	-62.9	+20.6
Georges Bank	-17.2	+170.3	-17.5	+16.0	+29.2
Mid Atlantic Bight	-33.3	-97.7	-08.6	-66.6	-76.5
Slope	-24.2	-	0.0	0.0	-45.4
Southern New England	-30.1	+08.7	+58.3	-	-05.0
TOTAL[1]	+13.4	-34.7	+58.5	-56.0	+05.3

	SPRING	SUMMER	AUTUMN	WINTER	TOTAL
Coastal	+33.3	+165.9	+90.0	-	+54.2
Gulf of Maine	-68.8	-25.2	-21.0	-	-23.7
Georges Bank	+14.1	-	+34.3	-	+29.7
Mid Atlantic Bight	+77.7	-	-53.8	-19.0	-41.2
Slope	+236.4	-	-	-	+909.1
Southern New England	+61.6	-31.6	-29.2	-	+10.0
TOTAL[1]	-17.9	-27.6	0.0	-76.6	-12.9

1 Weighted by effort within each region

Table 18. Number of delphinids per 100 transects in bottom trawl, MARMAP, and all NMFS surveys for 1980 through 1987 combined.

REGION	SUB-REGION	SPRING			SUMMER			AUTUMN			WINTER			ANNUAL TOTAL		
		BOTTOM	MARMAP	NMFS	BOTTOM	MARMAP	NMFS	BOTTOM	MARMAP	NMFS	BOTTOM	MARMAP	NMFS	BOTTOM	MARMAP	NMFS
GULF OF MAINE	WEST	0.0	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0
	CENTRAL GULF	0.8	140.6	29.9	-	6.2	64.9	94.2	57.9	81.1	-	30.1	26.7	47.5	58.7	50.7
	SOUTHWEST	77.6	103.7	226.3	0.0	15.2	27.9	168.8	35.4	110.2	-	10.8	38.6	82.1	41.3	100.7
	SOUTH	5.7	501.2	382.9	5000.0	160.0	160.7	65.3	9.1	44.4	-	0.0	155.0	1690.3	167.6	185.7
	REGION TOTAL	21.0	186.4	159.8	2500.0	45.3	63.48	82.1	25.6	58.9	-	10.2	55.1	541.2	66.9	84.3
GEORGES BANK	N. EDGE	0.0	212.1	104.5	300.0	0.0	77.1	272.7	0.0	230.8	-	314.8	293.1	190.9	131.7	176.4
	SHOALS	0.0	3.8	3.3	0.0	65.2	22.8	31.4	7.0	18.3	-	0.0	8.5	10.5	19.0	13.2
	CENTRAL BANK	41.6	22.6	40.3	57.1	12.5	224.0	2050.6	148.3	1242.1	-	121.1	119.2	716.4	76.1	406.4
	SHELF EDGE	43.4	0.0	29.7	-	117.4	445.7	1772.1	728.3	1253.3	-	128.2	197.7	907.7	243.5	481.6
	REGION TOTAL	21.3	59.6	44.5	119.0	48.8	192.4	1031.7	220.9	686.1	-	141.0	154.6	415.4	117.6	269.4
SOUTHERN NEW ENGLAND	INNER SHELF	27.2	16.3	19.8	0.0	0.0	3.9	0.0	5.9	3.0	0.0	37.5	71.7	6.8	14.9	24.6
	MIDDLE SHELF	42.6	57.8	47.3	28.6	462.3	68.9	177.7	36.4	113.3	76.9	139.0	155.0	81.4	173.9	96.1
	OUTER SHELF	10.6	277.6	139.4	-	0.0	126.5	141.1	16.7	97.3	0.0	60.0	100.0	50.6	88.6	115.8
	REGION TOTAL	26.8	117.2	68.9	14.3	154.1	66.4	106.3	19.6	71.2	25.6	78.8	108.9	45.9	92.5	78.8
MID-ATLANTIC BIGHT	INNER SHELF	0.0	30.2	24.4	-	38.7	21.5	3.4	2.6	2.4	0.0	0.0	22.1	1.1	17.9	17.6
	MIDDLE SHELF	192.2	227.9	220.0	-	0.0	47.0	15.3	30.3	26.3	144.1	450.0	318.5	117.2	177.1	152.9
	OUTER SHELF	47.9	329.7	218.9	-	40.0	569.0	150.0	53.2	117.1	66.7	5.4	46.2	88.2	109.6	237.8
	CAROLINA C.	72.7	114.3	108.1	-	0.0	0.0	0.0	7.1	3.0	-	-	-	36.4	40.5	37.0
	REGION TOTAL	78.2	175.5	142.8	-	19.7	159.4	42.2	23.3	37.2	70.3	155.1	128.9	62.9	89.3	116.3
COASTAL ZONE	STRATUM 96	7.4	0.0	5.6	0.0	0.0	0.0	0.0	212.8	114.9	0.0	31.0	23.7	1.9	60.9	36.1
	STRATUM 95	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	STRATUM 94	12.5	55.3	29.8	-	50.0	45.6	136.8	0.0	82.3	-	0.0	0.0	74.7	26.3	39.4
	REGION TOTAL	6.6	18.4	11.8	0.0	16.7	15.2	45.6	70.9	65.7	0.0	10.3	7.9	15.7	29.1	25.2
SLOPE	REGION TOTAL	55.6	1313.6	819.5	-	536.7	368.8	-	27.3	31.7	-	0.0	0.0	55.6	469.4	305.0
ALL REGIONS COMBINED		33.6	179.3	128.9	598.4	79.2	119.7	282.2	72.5	188.0	36.0	74.3	87.6	210.9	101.7	131.6

Table 19. THE TEN REGIONS WITH THE HIGHEST DENSITY (ANIMALS/TRANSECT) OF DOLPHINS IN THE STUDY AREA, 1980-1987, BY SEASON AND SUBREGION (FOR MARMAP SURVEYS ONLY).

REGION	SEASON	NUMBER/TRANSECT
SLOPE	Spring	13.14
GB-southern edge	Autumn	7.28
SLOPE	Summer	5.37
GOM-south	Spring	5.01
SNE-midshelf	Summer	4.62
MAB-midshelf	Winter	4.50
MAB-outershelf	Spring	3.30
GB-northern edge	Winter	3.15
SNE-outershelf	Spring	2.78
MAB-midshelf	Spring	2.28

Table 20. THE TEN REGIONS WITH THE HIGHEST DENSITY (ANIMALS/TRANSECT) OF DOLPHINS IN THE STUDY AREA, 1980-1987, BY SEASON AND SUBREGION (FOR TRAWL SURVEYS ONLY).

REGION	SEASON	NUMBER/TRANSECT
GOM-south	Summer	50.00
GB-central	Autumn	20.51
GB-southern edge	Autumn	17.72
GB-northern edge	Summer	3.00
GB-northern edge	Autumn	2.73
MAB-mid shelf	Spring	1.92
SNE-midshelf	Autumn	1.78
GOM-southwest	Autumn	1.69
MAB-outershelf	Autumn	1.50
MAB-midshelf	Winter	1.4

4. PERCENT DIFFERENCES BETWEEN THE NUMBER OF CETACEANS/TRANSECT FOR THE ENTIRE DATABASE AND FOR SELECTED SURVEY TYPES -DELPHINIDS.

The number of dolphins observed per transect on MARMAP surveys is (relative to the average) lower than the number observed on other survey types (Table 21). The only exception occurs in spring and is due to the high numbers of dolphins observed in the mid-Atlantic and southern New England areas at that time. In summer and autumn the number of dolphins observed per transect (for trawl surveys only) was higher than for the entire database (Table 21). The summer figures are unrealistically high, and do not present an accurate portrayal of the seasonal effort for the trawl surveys. The +399.9% difference represents a large sighting of dolphins with very little effort, resulting in a high number per transect. The winter results for the trawl survey is what we would expect since there is no winter trawl survey effort. The most valid comparison is between the number of dolphins observed on trawl surveys in spring and fall as compared to the number observed on MARMAP surveys during those seasons. It is apparent that most of the dolphins counted in spring are observed on MARMAP surveys and in fall on the trawl surveys.

Table 21. Percent difference between the number of delphinids per transect for MARMAP (upper) or for bottom trawl (lower) surveys, and for all NMFS surveys for 1980 through 1987 combined.

	SPRING	SUMMER	AUTUMN	WINTER	TOTAL
Coastal	+55.9	+09.8	+07.9	+30.4	+68.7
Gulf of Maine	+16.6	-28.6	-56.5	-81.4	-20.6
Georges Bank	+33.9	-74.6	-67.8	-08.7	-56.3
Mid Atlantic Bight	+22.9	-87.6	-37.4	+20.3	-23.2
Slope	+60.2	+45.4	-13.8	0.0	+53.9
Southern New England	+69.8	+131.8	-72.4	-27.6	+17.4
TOTAL[1]	+39.1	-33.8	-61.4	-15.2	-22.7

[1]Weighted by Effort for each region

	SPRING	SUMMER	AUTUMN	WINTER	TOTAL
Coastal	-44.1	-	-30.6	-	-37.7
Gulf of Maine	-86.8	+3838.0	+39.4	-	+541.9
Georges Bank	-52.1	-38.1	+50.4	-	+54.2
Mid Atlantic Bight	-45.2	-	+13.4	-45.5	-45.9
Slope	-93.2	-	-	0.0	-81.7
Southern New England	-61.1	-78.5	+49.2	-76.5	-41.8
TOTAL[1]	-73.9	+399.9	+50.1	-58.9	+60.2

[1]Weighted by Effort for each region

MONITORING CAPABILITIES-SPECIES ACCOUNTS

Distribution, Number of Sightings, and Number per transect.

1. BOTTLENOSED DOLPHIN *Tursiops truncatus*

Between Cape Hatteras and Nova Scotia, bottlenosed dolphins have a distinct J-shaped distribution consisting of an elongated offshore portion along the shelf edge and an abbreviated inshore portion between Cape Hatteras and Delaware Bay (Hain et al. 1981; CeTap 1982, data this report, Figure 6a-6d). The smaller, inshore form is found in coastal waters of the mid-Atlantic south of Delaware Bay (Hain et a. 1981). The larger form occurs offshore along the shelf edge from Cape Hatteras to at least northeastern Georges Bank (35o00N to 42o00N). Bottlenosed dolphins occur in the outer shelf waters of the mid-Atlantic to Georges Bank year around (Cetap 1982; Powers and Payne 1983). The offshore population remains similar in distributional range and abundance levels from May to October. The nearshore component has a relatively constant distribution and abundance during spring and summer, but is displaced southward in the fall and in winter is absent north of Cape Hatteras (Cetap 1982).

Sightings of bottlenosed dolphin occur within the Gulf of Maine in late summer to fall, but appear extralimital. This species is generally considered absent from the Gulf of Maine.

Monitoring from a shipboard platform

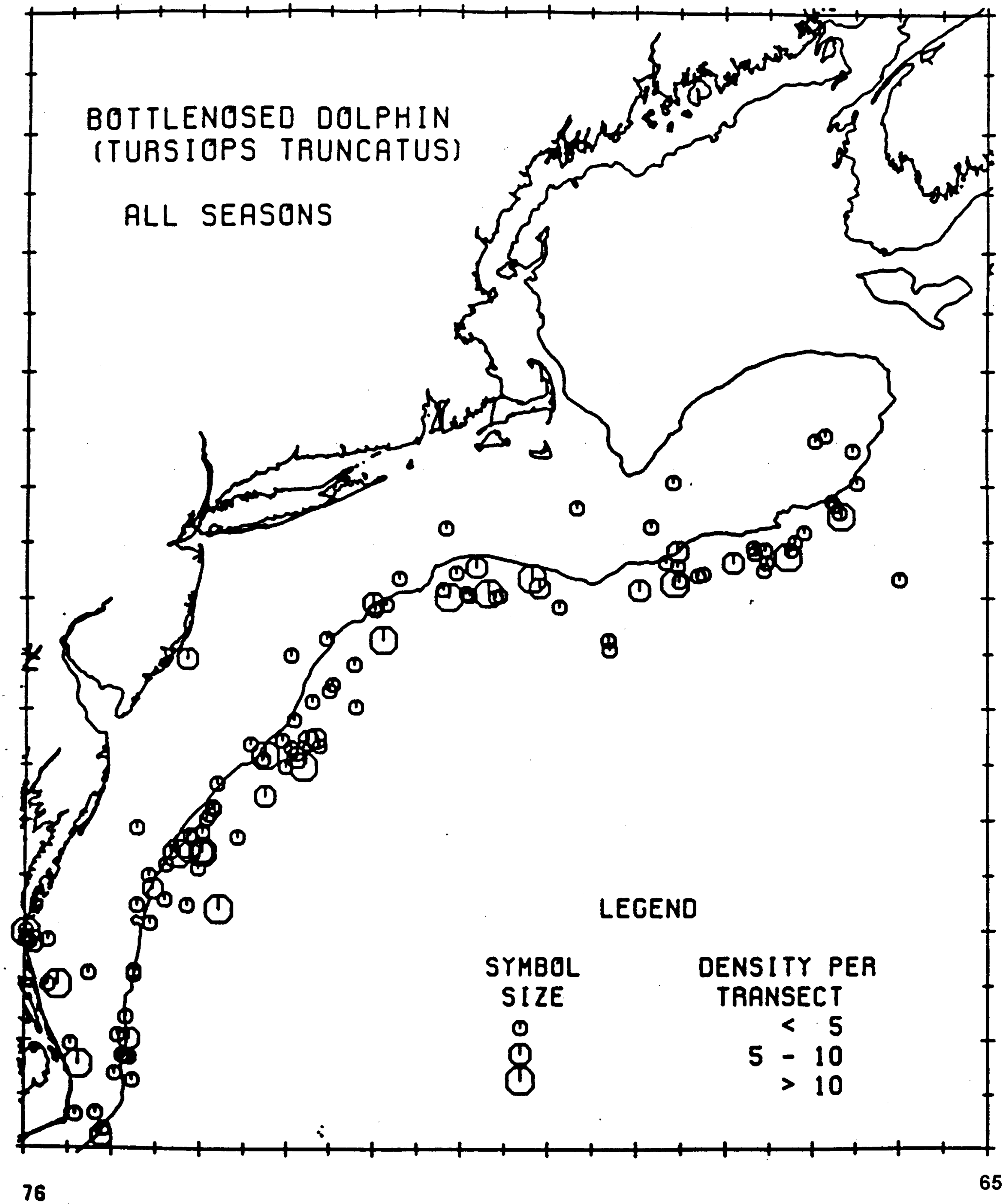
Monitoring of bottlenosed dolphins from standardized surveys would be best accomplished (based on the number of sightings per transect for data collected 1980-87, Table 22) in coastal mid-Atlantic waters (Inshore form) and mid-shelf to slope waters from the mid-Atlantic to Georges Bank during summer

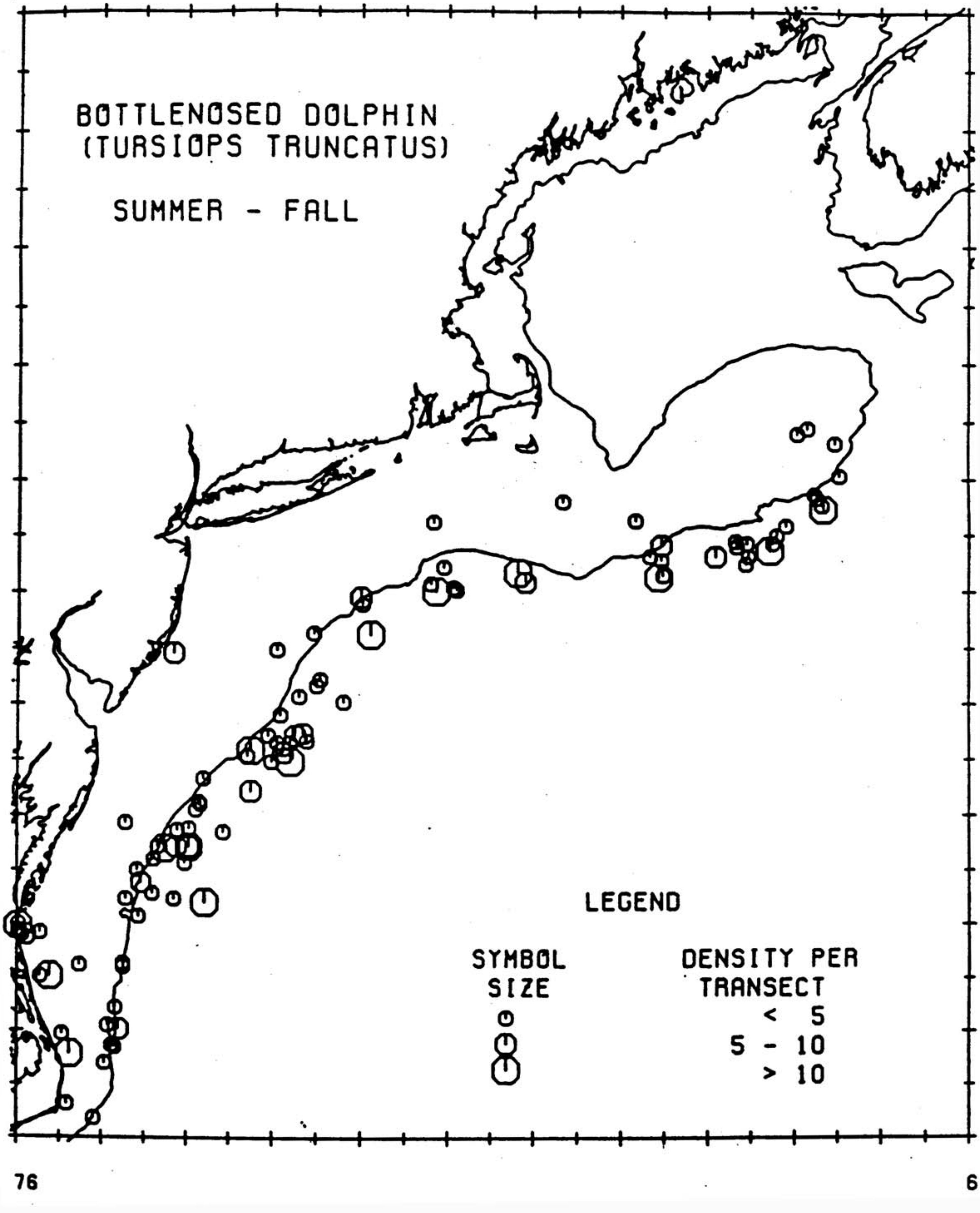
Figure 6a. Distribution of all bottlenosed dolphin sightings taken during shipboard surveys, for all seasons 1980-1986, in shelf waters of the northeastern United States.

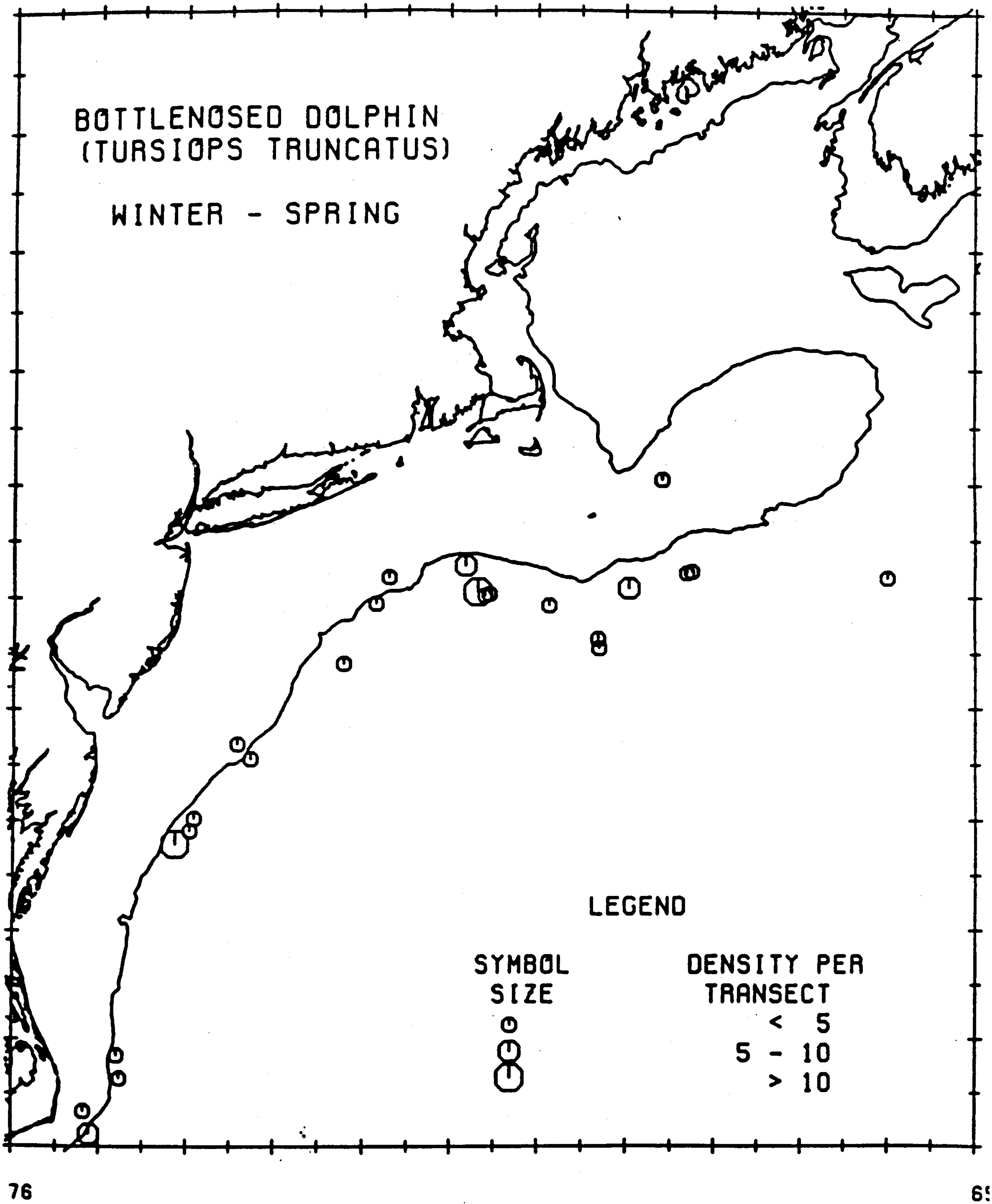
Figure 6b. Distribution of all bottlenosed dolphin sightings taken during shipboard surveys, for summer and fall 1980-1986, in shelf waters of the northeastern United States.

Figure 6c. Distribution of all bottlenosed dolphin sightings taken during shipboard surveys, for winter and spring 1980-1986, in shelf waters of the northeastern United States.

Figure 6d. Distribution of all bottlenosed dolphin sightings taken during shipboard surveys, by season, 1980-1986, in shelf waters of the northeastern United States.


BOTTLENOSED DOLPHIN
(TURSIOPS TRUNCATUS)
ALL SEASONS
LEGEND
SYMBOL SIZE
DENSITY PER TRANSECT
< 5
5 - 10
> 10
76
65


BOTTLENOSED DOLPHIN
(TURSIOPS TRUNCATUS)
SUMMER - FALL
LEGEND
SYMBOL SIZE
DENSITY PER TRANSECT
< 5
5 - 10
> 10
76


BOTTLENOSED DOLPHIN
(TURSIOPS TRUNCATUS)
WINTER - SPRING
LEGEND
SYMBOL SIZE
DENSITY PER TRANSECT
< 5
5 - 10
> 10
76
6

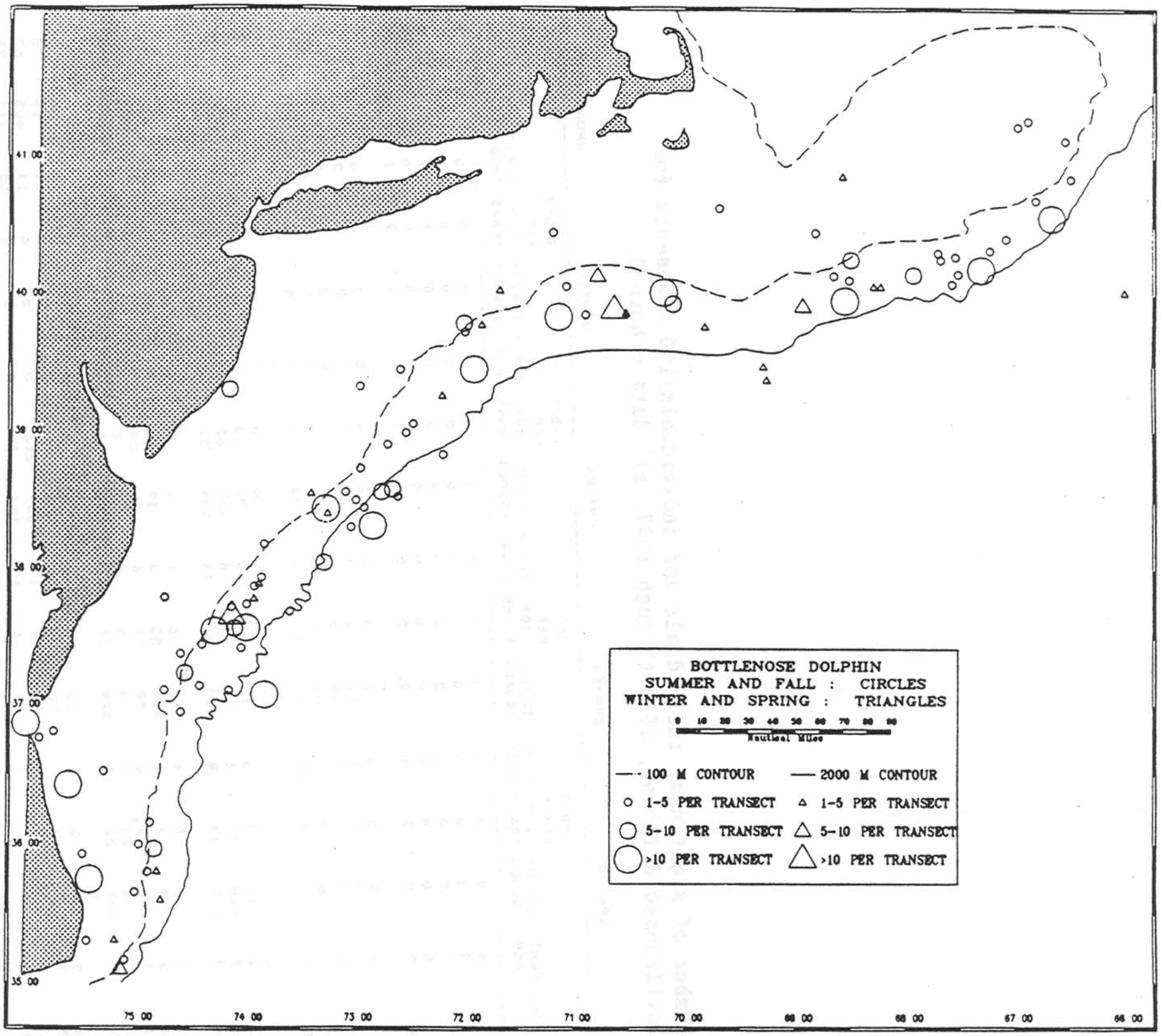

BOTTLENOSE DOLPHIN
SUMMER AND FALL : CIRCLES
WINTER AND SPRING : TRIANGLES
Nautical Miles
100 M CONTOUR
2000 M CONTOUR
1-5 PER TRANSECT
1-5 PER TRANSECT
5-10 PER TRANSECT
5-10 PER TRANSECT
>10 PER TRANSECT
>10 PER TRANSECT
41 00
40 00
39 00
38 00
37 00
36 00
35 00
75 00
74 00
73 00
72 00
71 00
70 00
69 00
68 00
67 00
66 00

Table 22. Number of sightings, individuals and individuals/100 transects for bottlenosed dolphins, 1980 through 1987, all data combined.

REGION	SUB-REGION	SPRING SGHT-INGS	SPRING INDIV-IDUALS	SPRING IND'S PER - 100 TRANS	SUMMER SGHT-INGS	SUMMER INDIV-IDUALS	SUMMER IND'S PER - 100 TRANS	AUTUMN SGHT-INGS	AUTUMN INDIV-IDUALS	AUTUMN IND'S PER - 100 TRANS	WINTER SGHT-INGS	WINTER INDIV-IDUALS	WINTER IND'S PER - 100 TRANS	ANNUAL TOTAL SGHT-INGS	ANNUAL TOTAL INDIV-IDUALS	ANNUAL TOTAL IND'S PER - 100 TRANS
GULF OF MAINE	WEST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CENTRAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SOUTHWEST	0	0	0	1	2	0	0	0	0	0	0	0	1	2	0
	SOUTH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	1	2	0	0	0	0	0	0	0	1	2	0
GEORGES BANK	N. EDGE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SHOALS	1	3	1	1	12	4	0	0	0	0	0	0	2	15	1
	CENTRAL	0	0	0	7	62	9	1	4	1	0	0	0	8	66	3
	SHELF EDGE	0	0	0	7	108	77	3	22	13	0	0	0	10	130	23
	TOTAL	1	3	0	15	182	23	4	26	4	0	0	0	20	211	7
SOUTHERN NEW ENGLAND	INN. SHELF	0	0	0	1	10	1	0	0	0	0	0	0	1	10	0
	MID. SHELF	2	12	2	3	17	2	3	76	15	0	0	0	8	105	5
	OUT. SHELF	7	108	37	4	83	44	8	175	62	0	0	0	19	366	36
	TOTAL	9	120	13	8	110	16	11	251	26	0	0	0	28	481	14
MID-ATLANTIC BIGHT	INN. SHELF	0	0	0	4	52	6	1	4	1	0	0	0	5	56	2
	MID. SHELF	2	19	6	6	238	53	3	39	12	0	0	0	11	296	18
	OUT. SHELF	5	105	56	8	88	51	6	50	24	2	12	18	21	255	37
	CAROL.CAPE	2	23	24	0	0	0	0	0	0	0	0	0	2	23	6
	TOTAL	9	147	21	18	378	27	10	93	9	2	12	5	39	630	16
COASTAL ZONE	STRATUM 96	0	0	0	1	20	10	0	0	0	0	0	0	1	20	2
	STRATUM 95	0	0	0	1	20	8	0	0	0	0	0	0	1	20	2
	STRATUM 94	1	6	5	2	12	9	10	387	213	0	0	0	13	405	57
	TOTAL	1	6	2	4	52	9	10	387	71	0	0	0	15	445	20
CONTINENTAL SLOPE		2	11	5	17	363	85	4	110	36	0	0	0	23	484	32
ALL REGIONS COMBINED		22	287	7	63	1087	19	39	867	20	2	12	1	126	2253	12

2. SPOTTED DOLPHINS Stenella spp.

Spotted dolphin taxonomy is not clear but Stenella attenuata/frontinalis and S. plagiodon occur in the western North Atlantic (Katona et al. 1977; Hain et al. 1981; Schmidly 1981; Cetap 1982), thus we refer to all spotted dolphins as Stenella spp.

Spotted dolphins are distributed broadly on the shelf, along the shelf edge, and offshore (>1000m) south of 40o00N, with evidence of a seasonal shift in the distribution pattern in winter (data this report, Figure 7a-7d). No spotted dolphins have been sighted north of Cape Hatteras in this season (Cetap 1982). Spotted dolphins regularly occur inthe inshore waters of the mid-Atlantic Bight south of Chesapeake Bay; otherwise their distribution is generally near the shelf edge and in slope waters. Sightings occur as far north as the slope waters of Georges Bank (41o00N) during mid-summer and fall, representing the northernmost extension of their range within our study area. Spotted dolphins have not been recorded in the Gulf of Maine.

Monitoring from shipboard surveys

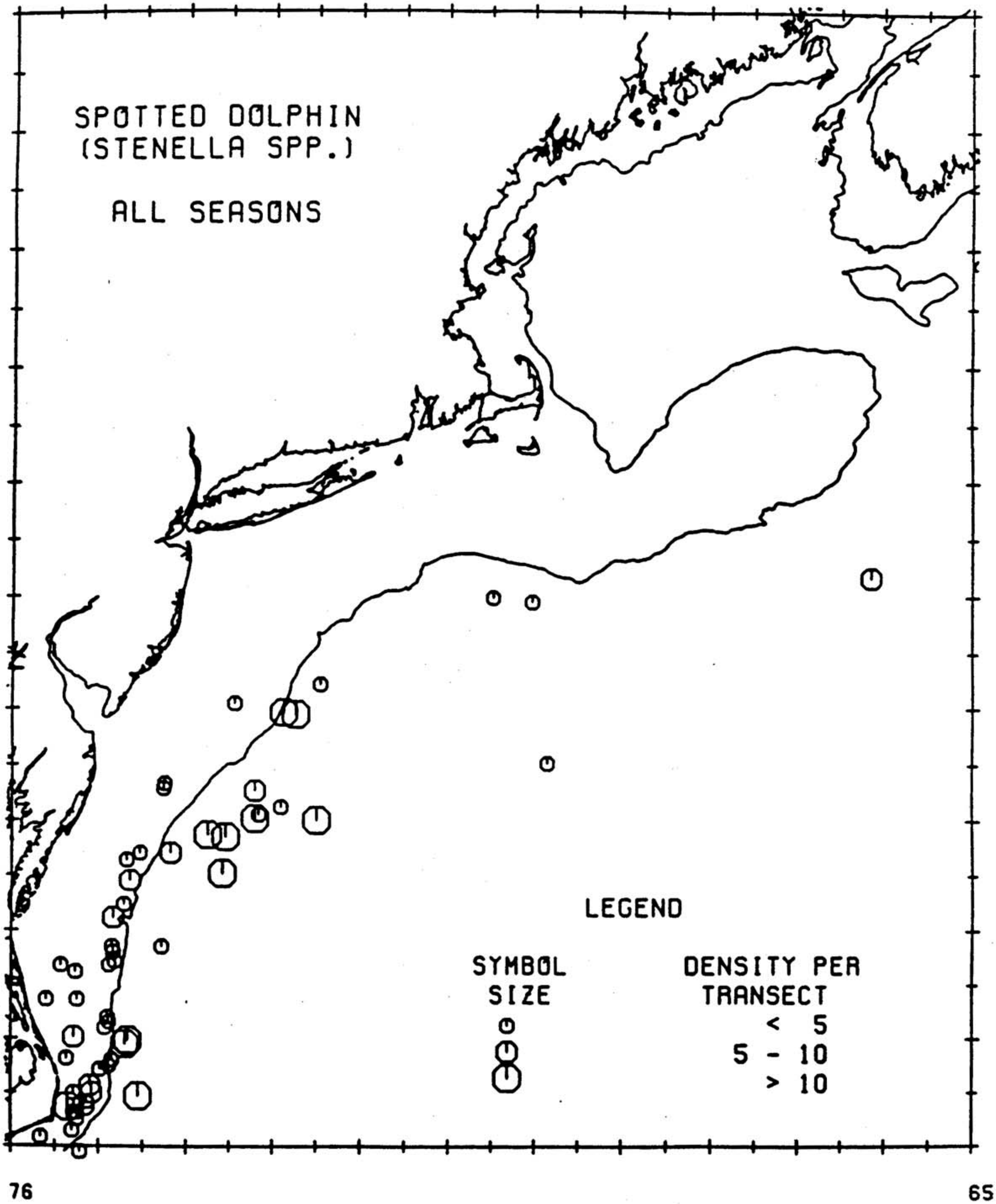
Based on the number of individuals per transect observed during standardized shipboard surveys (Table 23), spotted dolphins could best be monitored in shelf edge to slope waters of the mid-Atlantic and southern New England waters, spring through fall.

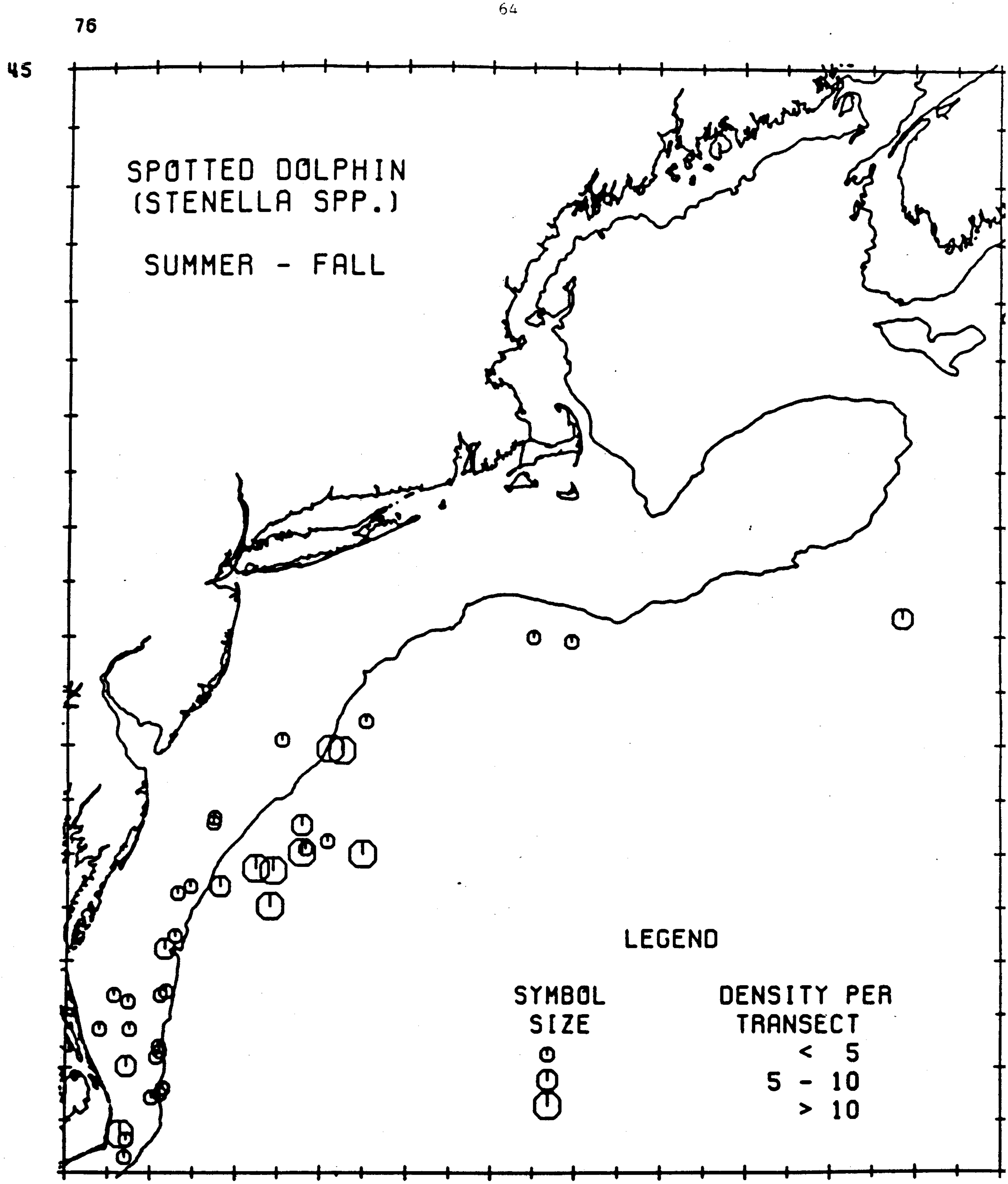
Figure 7a. Distribution of all spotted dolphin sightings taken during shipboard surveys, for all seasons 1980-1986, in shelf waters of the northeastern United States.

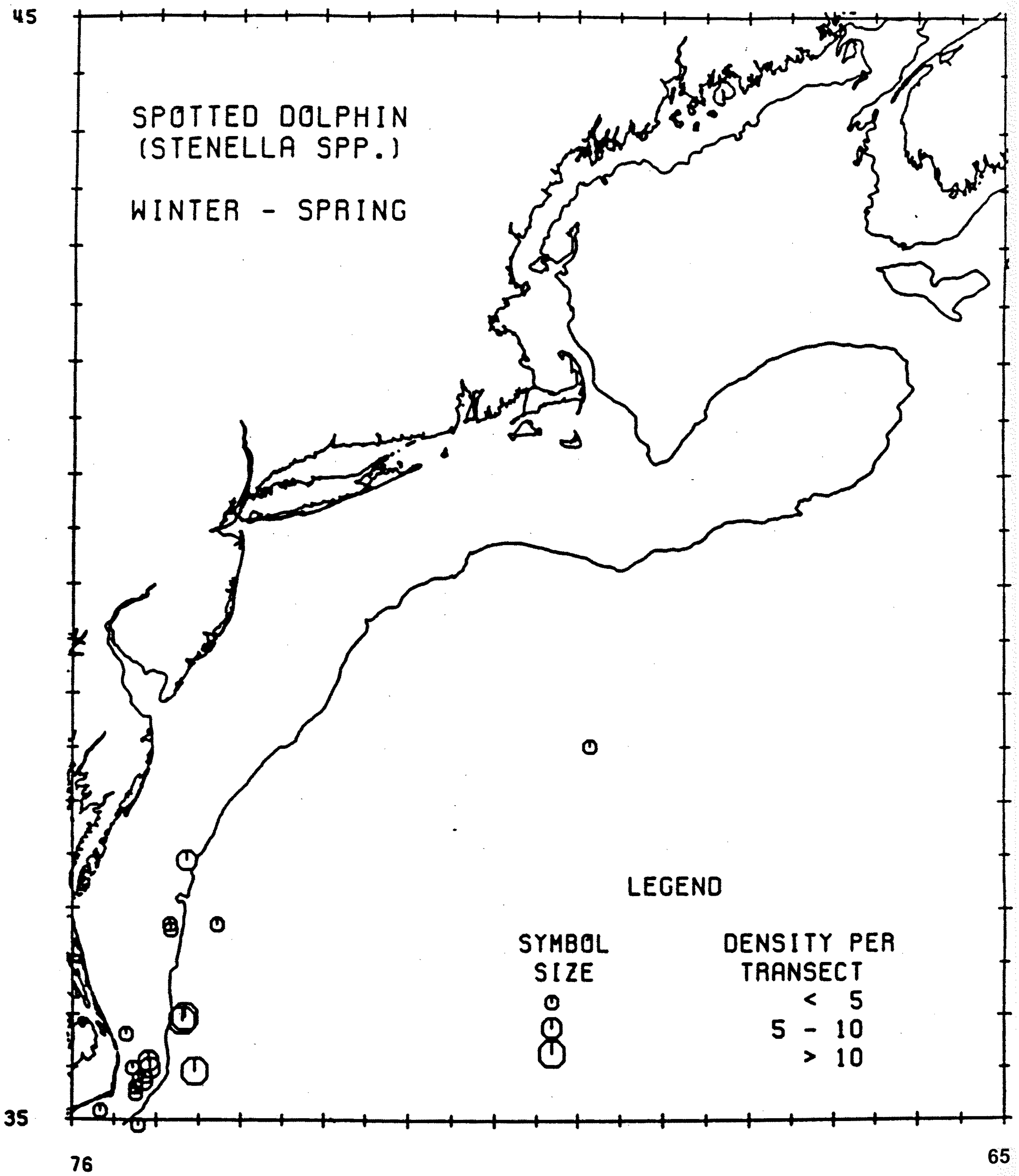
Figure 7b. Distribution of all spotted dolphin sightings taken during shipboard surveys, for summer and fall 1980-1986, in shelf waters of the northeastern United States.

Figure 7c. Distribution of all spotted dolphin sightings taken during shipboard surveys, for winter and spring 1980-1986, in shelf waters of the northeastern United States.

Figure 7d. Distribution of all spotted dolphin sightings taken during shipboard surveys, by season, 1980-1986, in shelf waters of the northeastern United States.


SPOTTED DOLPHIN
(STENELLA SPP.)
ALL SEASONS
LEGEND
SYMBOL SIZE
DENSITY PER TRANSECT
< 5
5 - 10
> 10
76
65


76
45
SPOTTED DOLPHIN
(STENELLA SPP.)
SUMMER - FALL
LEGEND
SYMBOL
SIZE
DENSITY PER
TRANSECT
< 5
5 - 10
> 10


45
35
76
65
SPOTTED DOLPHIN
(STENELLA SPP.)
WINTER - SPRING
LEGEND
SYMBOL
SIZE
DENSITY PER
TRANSECT
< 5
5 - 10
> 10

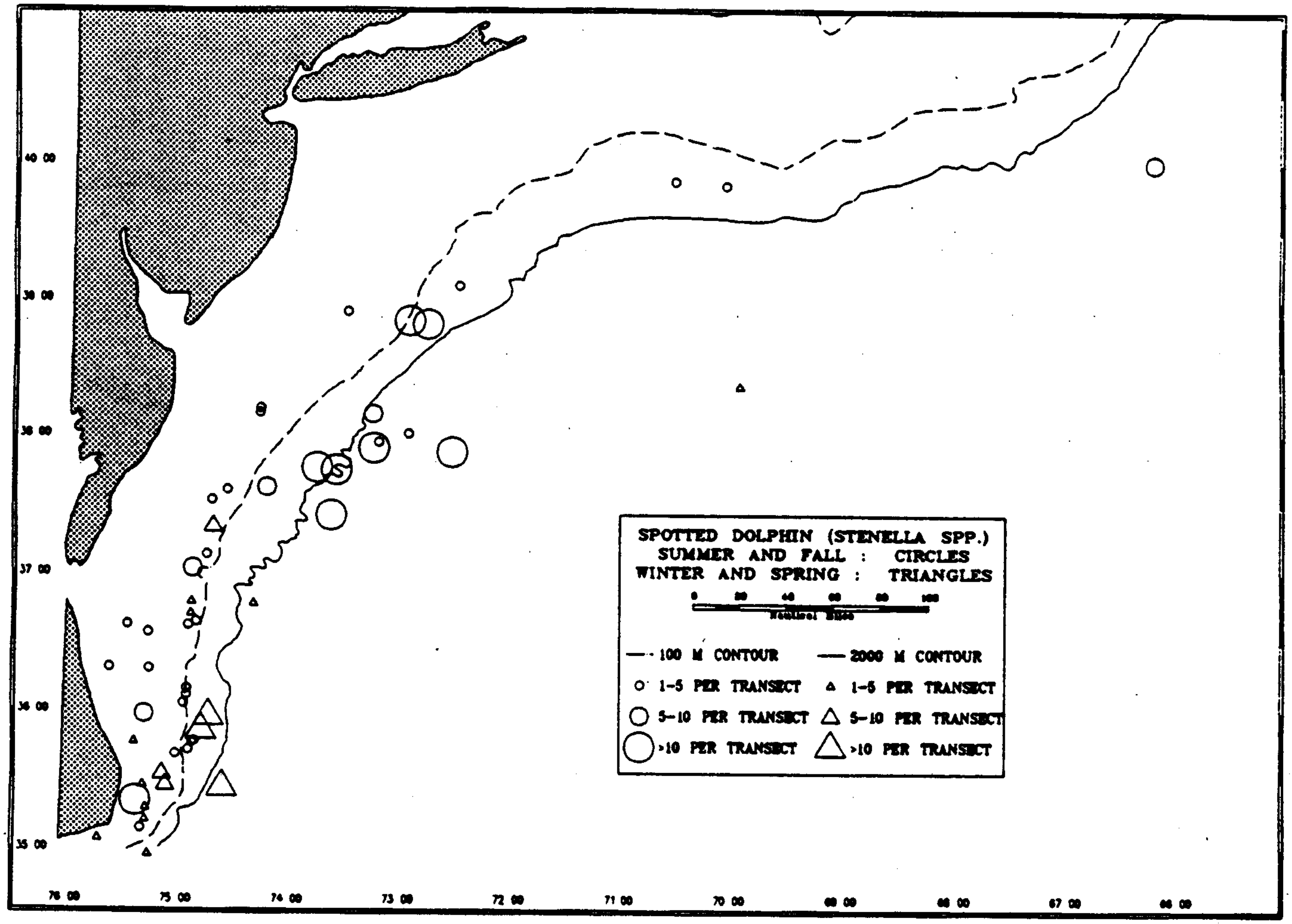

SPOTTED DOLPHIN (STENELLA SPP.)
SUMMER AND FALL : CIRCLES
WINTER AND SPRING : TRIANGLES
100 M CONTOUR
2000 M CONTOUR
1-5 PER TRANSECT
1-5 PER TRANSECT
5-10 PER TRANSECT
5-10 PER TRANSECT
>10 PER TRANSECT
>10 PER TRANSECT
40 00
37 00
35 00
75 00
74 00
73 00
72 00
71 00
70 00
67 00

Table 23. Number of sightings, individuals and individuals/100 transects for spotted or bridled dolphins, 1980 through 1987, all data combined.

REGION	SUB-REGION	SPRING SGHT-INGS	SPRING INDIV-IDUALS	SPRING IND'S PER - 100 TRANS	SUMMER SGHT-INGS	SUMMER INDIV-IDUALS	SUMMER IND'S PER - 100 TRANS	AUTUMN SGHT-INGS	AUTUMN INDIV-IDUALS	AUTUMN IND'S PER - 100 TRANS	WINTER SGHT-INGS	WINTER INDIV-IDUALS	WINTER IND'S PER - 100 TRANS	ANNUAL TOTAL SGHT-INGS	ANNUAL TOTAL INDIV-IDUALS	ANNUAL TOTAL IND'S PER - 100 TRANS
GULF OF MAINE	WEST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CENTRAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SOUTHWEST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SOUTH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GEORGES BANK	N. EDGE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SHOALS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CENTRAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SHELF EDGE	0	0	0	1	4	3	1	15	9	0	0	0	2	19	3
	TOTAL	0	0	0	1	4	1	1	15	2	0	0	0	2	19	1
SOUTHERN NEW ENGLAND	INN. SHELF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	MID. SHELF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	OUT. SHELF	0	0	0	4	116	62	2	24	9	0	0	0	6	140	18
	TOTAL	0	0	0	4	116	21	2	24	3	0	0	0	6	140	6
MID-ATLANTIC BIGHT	INN. SHELF	2	39	7	17	142	16	0	0	0	0	0	0	19	181	6
	MID. SHELF	2	38	12	5	54	12	1	1	0	0	0	0	8	93	6
	OUT. SHELF	1	125	66	4	94	54	0	0	0	0	0	0	5	219	30
	CAROL.CAPE	5	79	81	1	4	17	0	0	0	0	0	0	6	83	25
	TOTAL	10	281	42	27	294	25	1	1	0	0	0	0	38	576	17
COASTAL ZONE	STRATUM 96	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	STRATUM 95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	STRATUM 94	3	27	20	2	13	10	2	75	41	0	0	0	7	115	18
	TOTAL	3	27	7	2	13	3	2	75	14	0	0	0	7	115	6
CONTINENTAL SLOPE		4	285	125	4	286	67	2	50	17	0	0	0	10	421	52
ALL REGIONS COMBINED		17	593	16	38	713	13	8	165	4	0	0	0	63	1471	8

3. STRIPED DOLPHIN Stenella coerueoalba

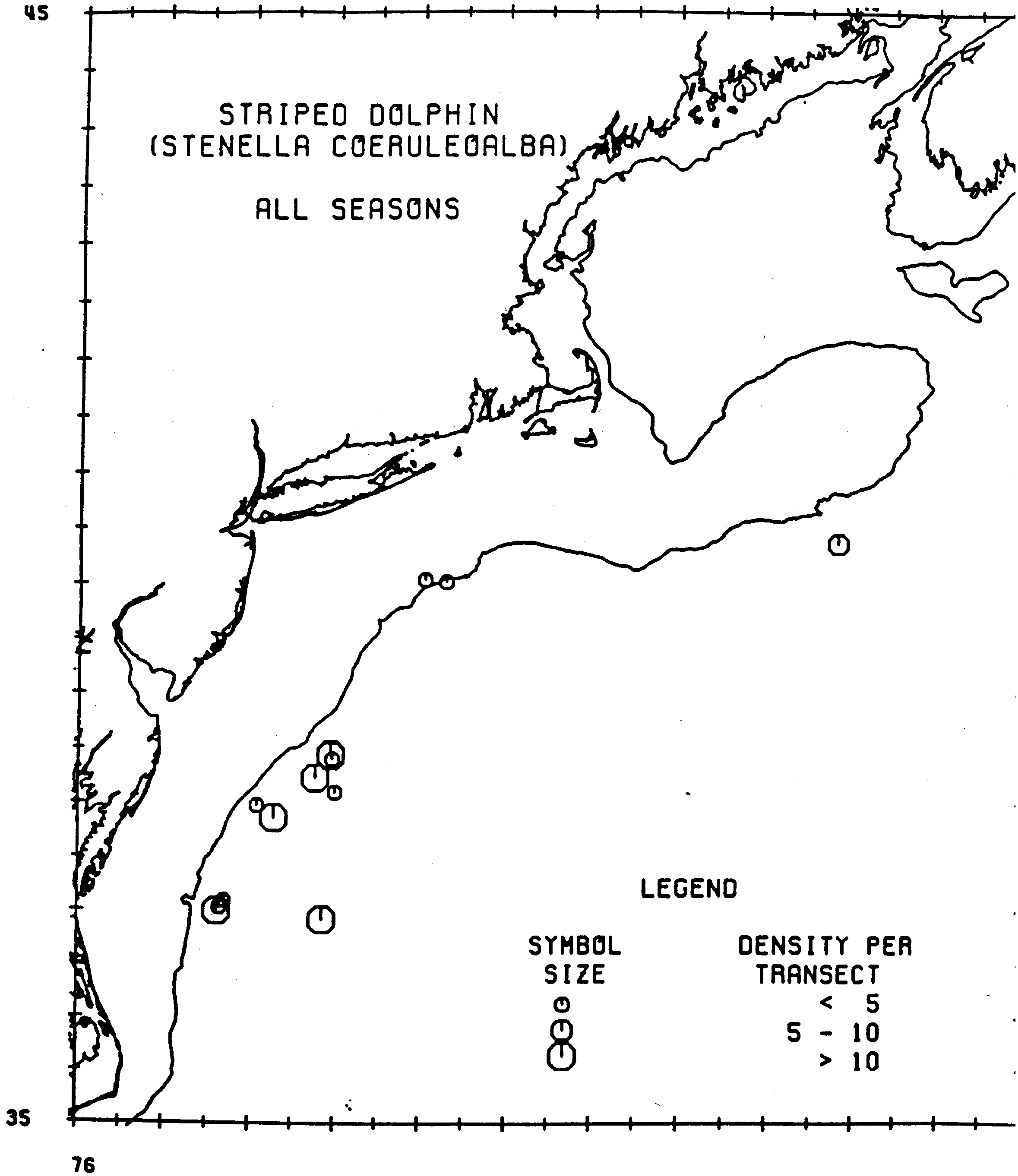
Striped dolphin Stenella coeruleoalba are known mainly from tropical and temperate waters of the Atlantic and Pacific, preferring offshore waters (rather than shelf waters), with seasonal movements poleward in spring and summer, and toward the equator in autumn-winter (Watson 1981). In our study area, striped dolphins are distributed along the shelf edge from Cape Hatteras to the southern Margin of Georges Bank, and offshore, generally seaward of the 1000m isobath (data from this report, Figures 8a, 8b). Cetap (1982) showed that in spring there is a concentration of striped dolphins along the shelf edge in the mid-Atlantic, and another southeast of Nantucket along the southwest edge of Georges Bank. The latter area is occupied throughout the year (Cetap 1982). Striped dolphins are recorded infrequently within the Gulf of Maine.

Monitoring from shipboard observations

Monitoring striped dolphins from standardized shelf surveys is difficult in that the edge of the shelf is marginal habitat for this species (data from Table 24). Shipboard surveys should be conducted in shelf-edge and slope waters, spring through fall, to effectively monitor this species.

Figure 8a. Distribution of all striped dolphin sightings taken during shipboard surveys, for all seasons 1980-1986, in shelf waters of the northeastern United States.

Figure 8b. Distribution of all striped dolphin sightings taken during shipboard surveys, by season, 1980-1986, in shelf waters of the northeastern United States.


45
STRIPED DOLPHIN
(STENELLA COERULEOALBA)
ALL SEASONS
LEGEND
SYMBOL SIZE
DENSITY PER TRANSECT
< 5
5 - 10
> 10
35
76

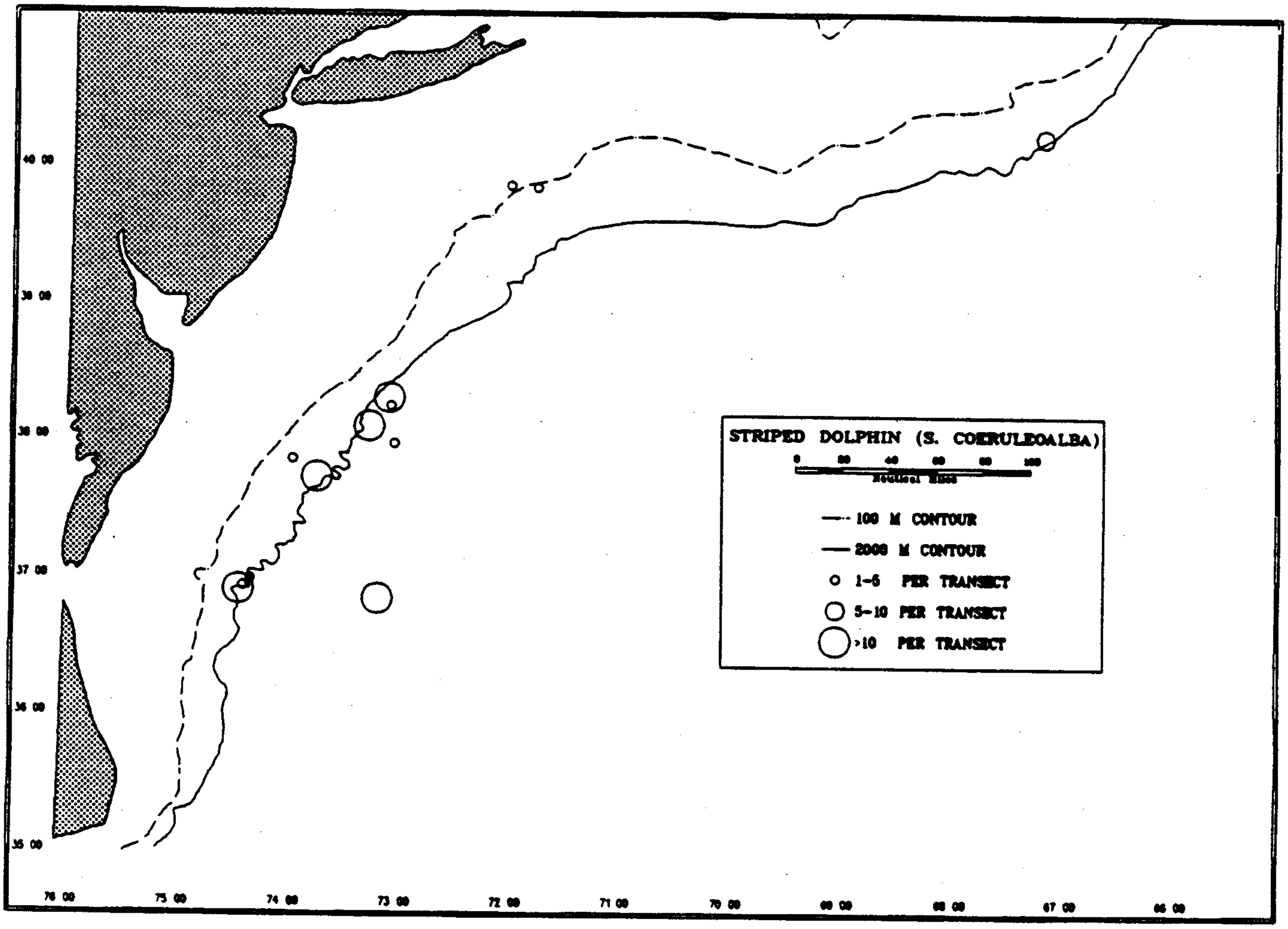

STRIPED DOLPHIN (S. COERULEOALBA)
100 M CONTOUR
2000 M CONTOUR
1-5 PER TRANSECT
5-10 PER TRANSECT
>10 PER TRANSECT

Table 24. Number of sightings, individuals and individuals/100 transects for striped dolphins, 1980 through 1987, all data combined.

REGION	SUB-REGION	SPRING			SUMMER			AUTUMN			WINTER			ANNUAL TOTAL		
		SGHT-INGS	INDIV-IDUALS	IND'S PER - 100 TRANS	SGHT-INGS	INDIV-IDUALS	IND'S PER - 100 TRANS	SGHT-INGS	INDIV-IDUALS	IND'S PER - 100 TRANS	SGHT-INGS	INDIV-IDUALS	IND'S PER - 100 TRANS	SGHT-INGS	INDIV-IDUALS	IND'S PER - 100 TRANS
GULF OF MAINE	WEST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CENTRAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SOUTHWEST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SOUTH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GEORGES BANK	N. EDGE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SHOALS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CENTRAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SHELF EDGE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SOUTHERN NEW ENGLAND	INN. SHELF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	MID. SHELF	0	0	0	1	6	1	1	7	1	0	0	0	2	13	1
	OUT. SHELF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	1	6	0	1	7	0	0	0	0	2	13	0
MID-ATLANTIC BIGHT	INN. SHELF	0	0	0	1	3	0	0	0	0	0	0	0	1	3	0
	MID. SHELF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	OUT. SHELF	0	0	0	0	0	0	1	10	5	0	0	0	1	10	1
	CAROL.CAPE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	1	3	0	1	10	1	0	0	0	2	13	0
COASTAL ZONE	STRATUM 96	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	STRATUM 95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	STRATUM 94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CONTINENTAL SLOPE		4	119	52	2	175	41	4	250	83	0	0	0	10	544	44
ALL REGIONS COMBINED		4	119	3	4	184	2	6	267	5	0	0	0	14	570	2

4. COMMON OR SADDLEBACK DOLPHIN Delphinus delphis

Common dolphin Delphinus delphis are widespread from Cape Hatteras northeastward to the eastern tip of Georges Bank (35o00 N to 42o00N) in mid-to-outer shelf waters, on a year round basis (data this report, Figure 9a-9d). Sightings in the Gulf of Maine are limited to fall and winter, generally on the northeastern edge of Georges Bank. Their mid-shelf distribution is evident especially from Georges Bank southward (Figure 9a, 9d). Greatest sighting frequencies occurred on central Georges Bank in fall (Table 25); however, common dolphins are abundant on Georges Bank May to June and again from October to December. There is a decrease in sightings during mid-to late summer when common dolphins apparentlly move north onto the Scotian Shelf. Hain et al (1981) suggested that summer and fall sightings are greatest north of 37o30N and winter and spring sightings south of this latitude; however common dolphins occur commonly on Georges Bank throughout the winter.

Common dolphin are year round residents south of the Gulf of Maine, and are considered stragglers into the Gulf of Maine.

Monitoring common dolphins from shipboard surveys

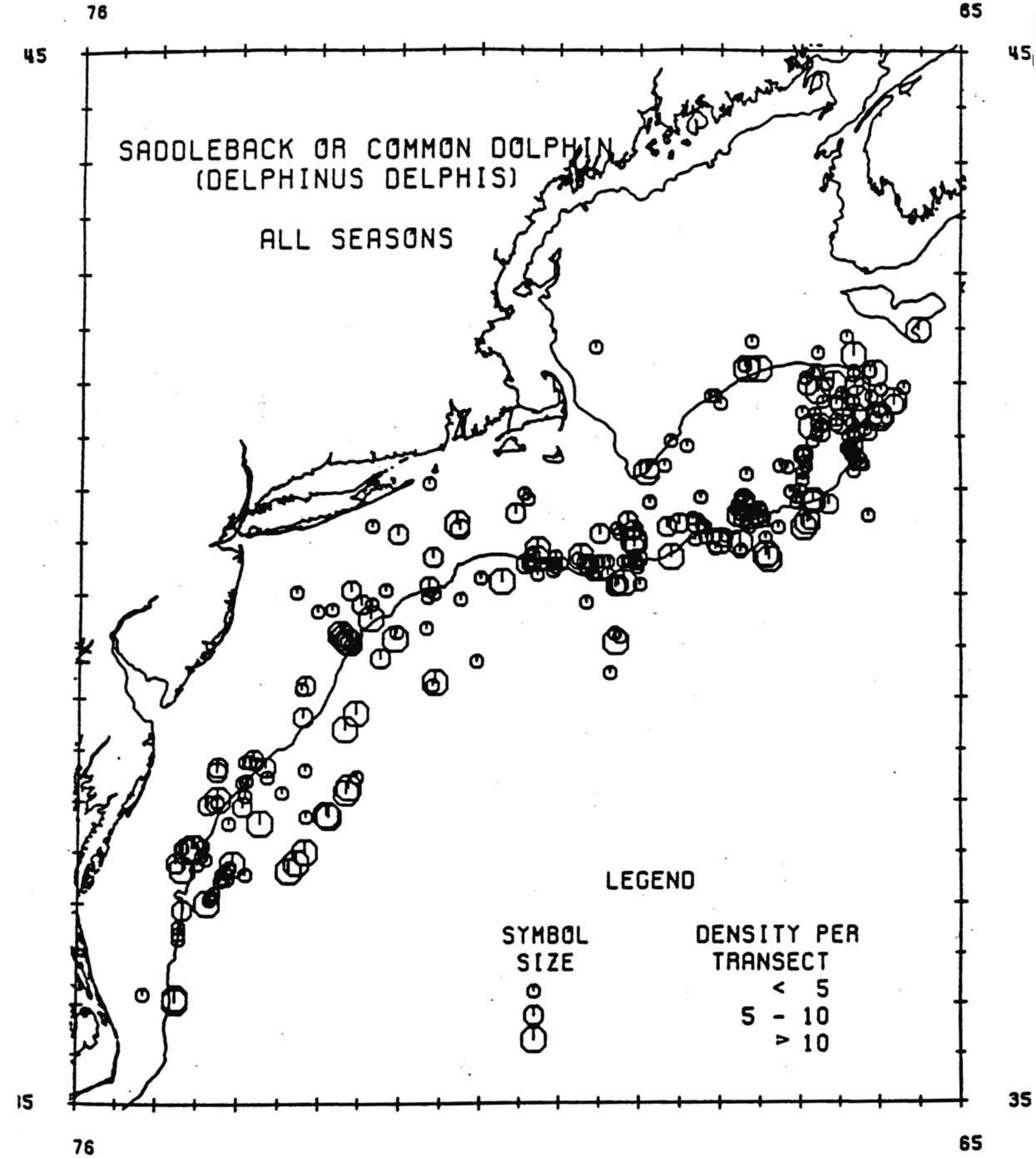
Based on the sighting per transect frequencies (Table 25), common dolphins could be monitored throughout the year, throughout the study area.

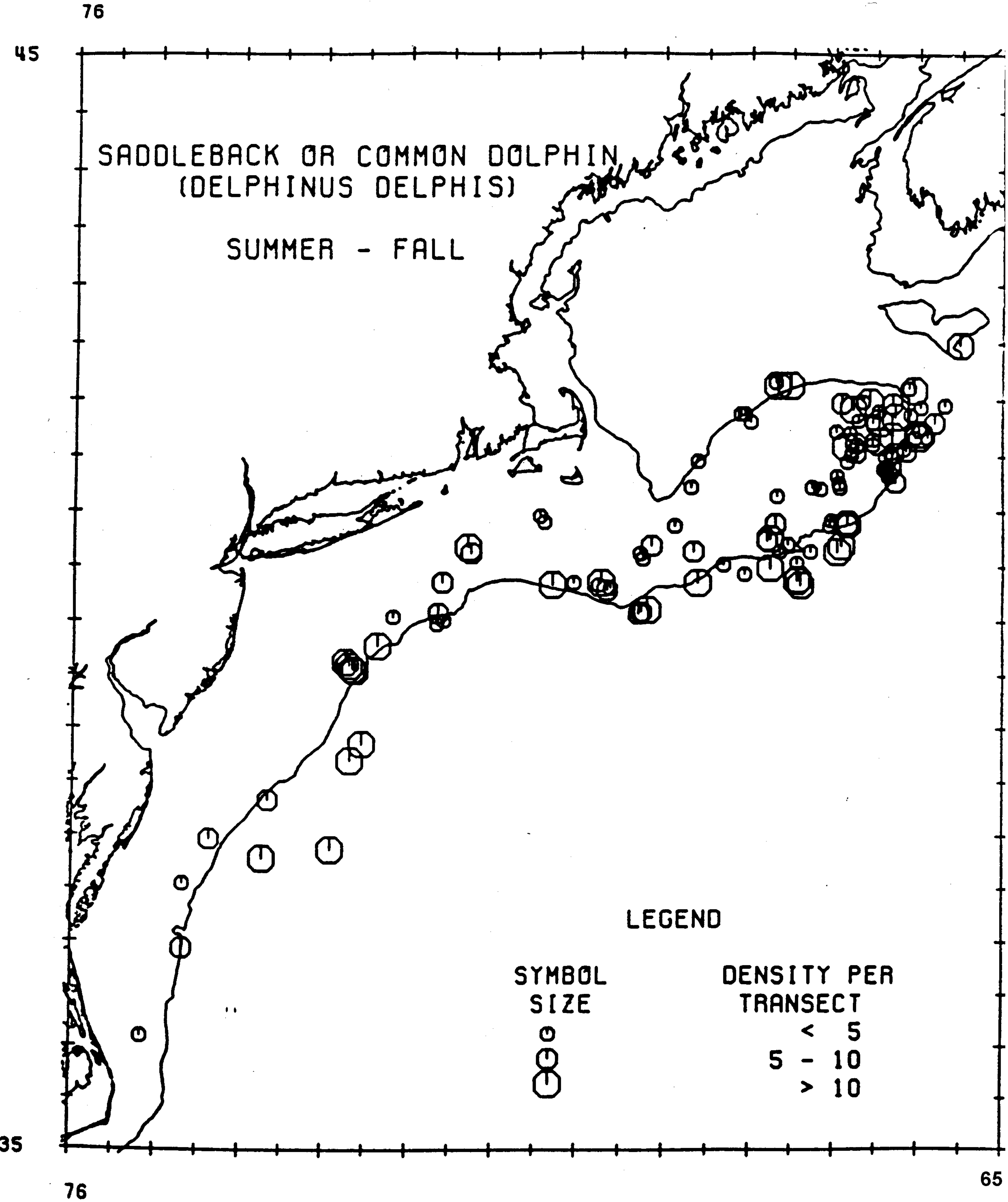
Figure 9a. Distribution of all saddleback dolphin sightings taken during shipboard surveys, for all seasons 1980-1986, in shelf waters of the northeastern United States.

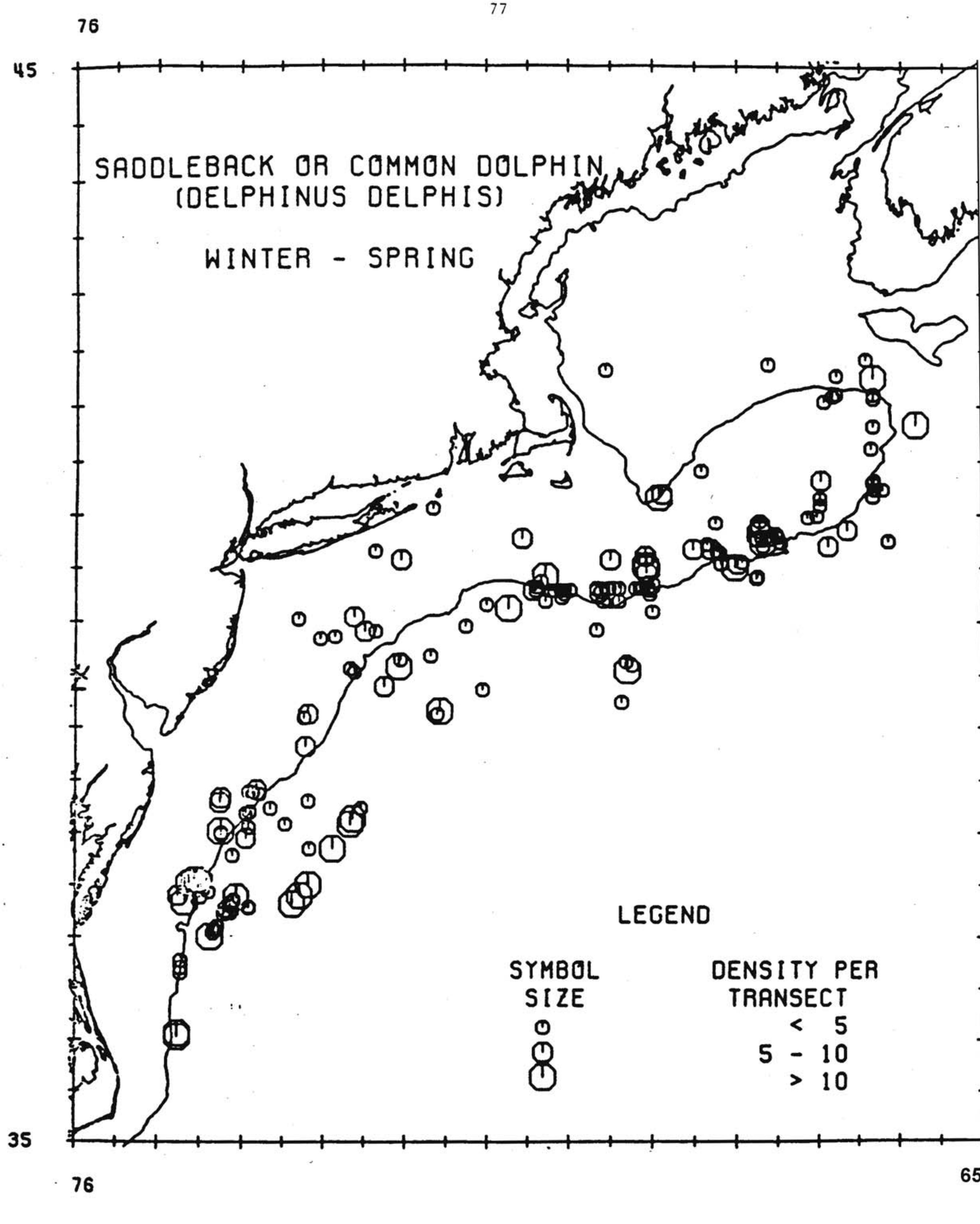
Figure 9b. Distribution of all saddleback dolphin sightings taken during shipboard surveys, for summer and fall 1980-1986, in shelf waters of the northeastern United States.

Figure 9c. Distribution of all saddleback dolphin sightings taken during shipboard surveys, for winter and spring 1980-1986, in shelf waters of the northeastern United States.

Figure 9d. Distribution of all saddleback dolphin sightings taken during shipboard surveys, by season, 1980-1986, in shelf waters of the northeastern United States.


76
65
45
45
SADDLEBACK OR COMMON DOLPHIN
(DELPHINUS DELPHIS)
ALL SEASONS
LEGEND
SYMBOL SIZE
DENSITY PER TRANSECT
< 5
5 - 10
> 10
35
35
76
65


76
45
SADDLEBACK OR COMMON DOLPHIN
(DELPHINUS DELPHIS)
SUMMER - FALL
LEGEND
SYMBOL SIZE
DENSITY PER TRANSECT
< 5
5 - 10
> 10
35
76
65


76
45
SADDLEBACK OR COMMON DOLPHIN
(DELPHINUS DELPHIS)
WINTER - SPRING
LEGEND
SYMBOL
SIZE
DENSITY PER
TRANSECT
< 5
5 - 10
> 10
35
76
65

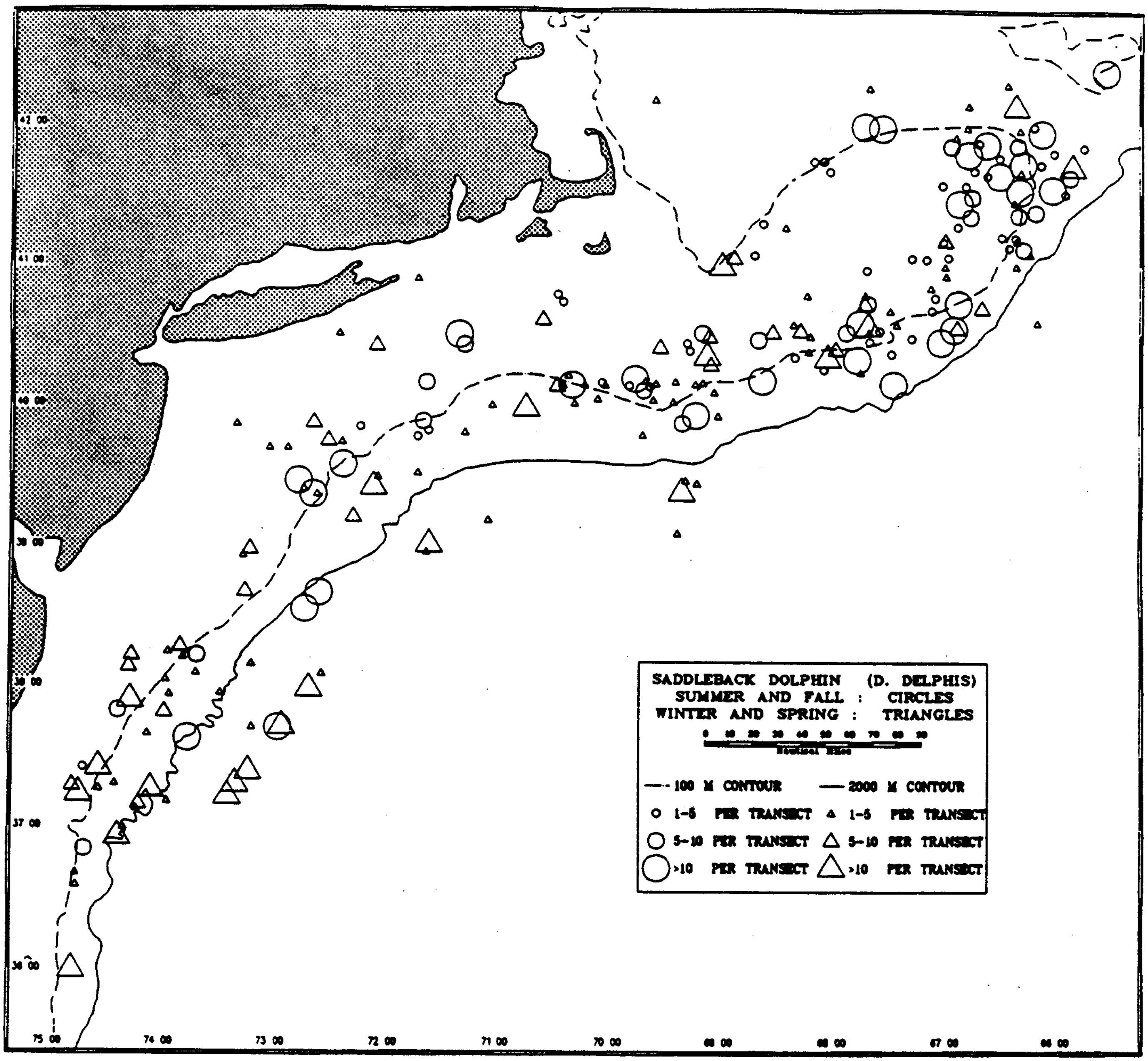

SADDLEBACK DOLPHIN (D. DELPHIS)
SUMMER AND FALL : CIRCLES
WINTER AND SPRING : TRIANGLES
100 M CONTOUR
2000 M CONTOUR
1-5 PER TRANSECT
5-10 PER TRANSECT
>10 PER TRANSECT
1-5 PER TRANSECT
5-10 PER TRANSECT
>10 PER TRANSECT

Table 25. Number of sightings, individuals and individuals/100 transects for saddleback or common dolphins, 1980 through 1987, all data combined.

		SPRING			SUMMER			AUTUMN			WINTER			ANNUAL TOTAL		
REGION	SUB-REGION	SGHT-INGS	INDIV-IDUALS	IND'S PER - 100 TRANS	SGHT-INGS	INDIV-IDUALS	IND'S PER - 100 TRANS	SGHT-INGS	INDIV-IDUALS	IND'S PER - 100 TRANS	SGHT-INGS	INDIV-IDUALS	IND'S PER - 100 TRANS	SGHT-INGS	INDIV-IDUALS	IND'S PER - 100 TRANS
GULF OF MAINE	WEST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CENTRAL	1	2	1	0	0	0	2	13	3	2	4	1	5	19	1
	SOUTHWEST	1	6	3	0	0	0	2	23	10	0	0	0	3	29	3
	SOUTH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	2	8	1	0	0	0	4	36	3	2	4	0	8	48	1
GEORGES BANK	N. EDGE	0	0	0	11	613	639	6	238	211	3	85	293	20	936	286
	SHOALS	0	0	0	0	0	0	2	9	4	1	7	9	3	16	3
	CENTRAL	6	47	14	34	1096	160	37	3795	942	14	224	95	91	5162	303
	SHELF EDGE	2	33	26	1	6	4	6	1089	652	5	100	227	14	1228	227
	TOTAL	8	80	10	46	1715	201	51	5131	452	23	416	156	128	7342	205
SOUTHERN NEW ENGLAND	INN. SHELF	4	35	10	1	58	8	3	15	3	3	48	26	11	156	12
	MID. SHELF	7	64	12	10	335	39	12	479	93	29	393	152	58	1271	74
	OUT. SHELF	5	69	24	0	0	0	1	3	1	2	20	40	8	92	16
	TOTAL	16	168	15	11	393	16	16	497	32	34	461	73	77	1519	34
MID-ATLANTIC BIGHT	INN. SHELF	3	43	7	2	14	2	0	0	0	3	49	18	8	106	7
	MID. SHELF	10	453	148	4	42	9	0	0	0	10	287	271	24	782	107
	OUT. SHELF	4	43	23	0	0	0	4	458	219	1	12	18	9	513	65
	CAROL.CAPE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	17	539	44	6	56	3	4	458	55	14	348	77	41	1401	45
COASTAL ZONE	STRATUM 96	0	0	0	0	0	0	0	0	0	1	4	3	1	4	1
	STRATUM 95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	STRATUM 94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	1	4	1	1	4	0
CONTINENTAL SLOPE		29	1086	476	0	0	0	1	100	33	0	0	0	30	1186	127
ALL REGIONS COMBINED		72	1881	39	63	2164	45	76	6222	114	74	1233	61	285	11500	65

5. ATLANTIC WHITE-SIDED DOLPHIN *Lagenorhynchus acutus*

Atlantic white-sided dolphin *Lagenorhynchus acutus* are widespread throughout the Gulf of Maine and Georges Bank throughout the year south to approximately 40o00N. Within these regions they are most abundant in the southwestern Gulf of Maine (data this report, Figure 10a-10d). Hain et al. (1981) suggested that their distribution is most widespread October to November, with spring to fall sightings along the shelf edge from south of Nantucket to Virginia, but not in winter. Whitesided dolphins were most widespread winter and spring, and most abundant in spring (from Table 26). This species is found year round only in the Gulf of Maine where it is the dominant delphinid. The areas of greatest concentrations were in the south and southwest regions of the Gulf of Maine.

Monitoring from shipboard surveys

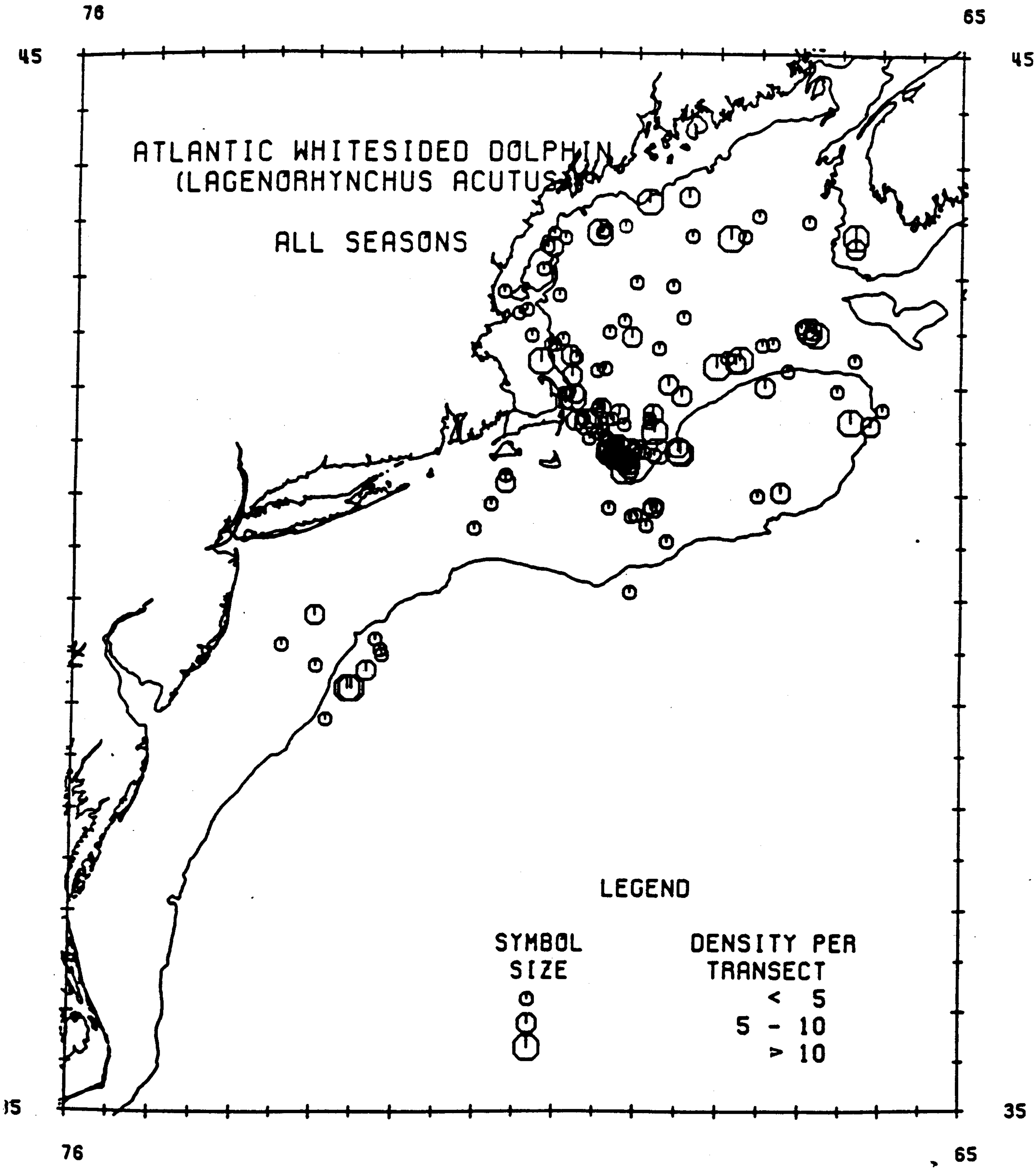
Based on the number of sightings per transect (Table 26) whitesided dolphin can be monitored in the south and southwest Gulf of Maine, year-round.

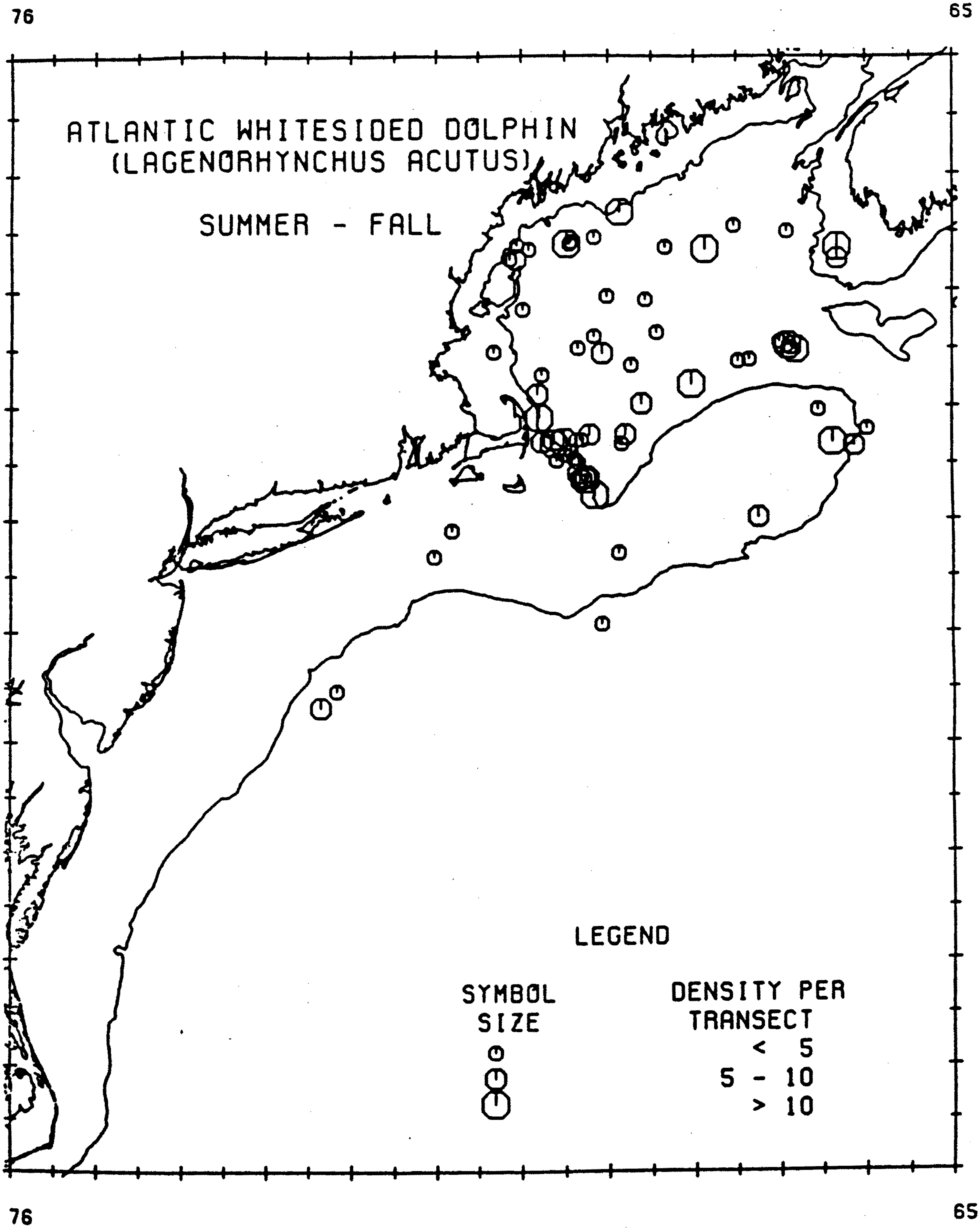
Figure 10a. Distribution of all white-sided dolphin sightings taken during shipboard surveys, for all seasons 1980-1986, in shelf waters of the northeastern United States.

Figure 10b. Distribution of all white-sided dolphin sightings taken during shipboard surveys, for summer and fall 1980-1986, in shelf waters of the northeastern United States.

Figure 10c. Distribution of all white-sided dolphin sightings taken during shipboard surveys, for winter and spring 1980-1986, in shelf waters of the northeastern United States.

Figure 10d. Distribution of all white-sided dolphin sightings taken during shipboard surveys, by season, 1980-1986, in shelf waters of the northeastern United States.


ATLANTIC WHITESIDED DOLPHIN
(LAGENORHYNCHUS ACUTUS)
ALL SEASONS
76
65
45
45
35
76
65
LEGEND
SYMBOL SIZE
DENSITY PER TRANSECT
< 5
5 - 10
> 10


76
65
ATLANTIC WHITESIDED DOLPHIN
(LAGENORHYNCHUS ACUTUS)
SUMMER - FALL
LEGEND
SYMBOL SIZE
DENSITY PER TRANSECT
< 5
5 - 10
> 10
76
65

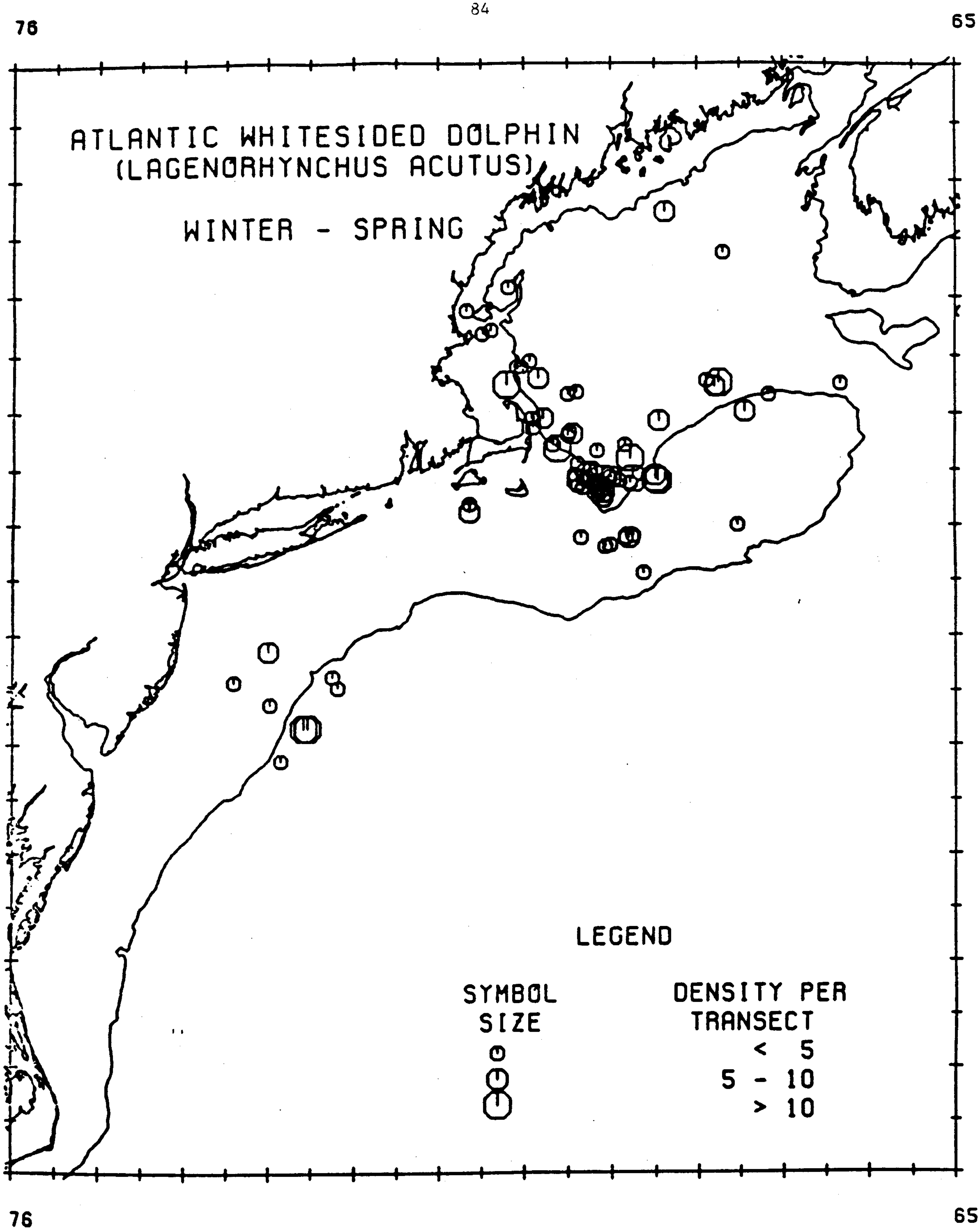

76
65
ATLANTIC WHITESIDED DOLPHIN
(LAGENORHYNCHUS ACUTUS)
WINTER - SPRING
LEGEND
SYMBOL SIZE
DENSITY PER TRANSECT
< 5
5 - 10
> 10
76
65

Table 26. Number of sightings, individuals and individuals/100 transects for whitesided dolphins, 1980 through 1987, all data combined.

REGION	SUB-REGION	SPRING SGHT-INGS	SPRING INDIV-IDUALS	SPRING IND'S PER - 100 TRANS	SUMMER SGHT-INGS	SUMMER INDIV-IDUALS	SUMMER IND'S PER - 100 TRANS	AUTUMN SGHT-INGS	AUTUMN INDIV-IDUALS	AUTUMN IND'S PER - 100 TRANS	WINTER SGHT-INGS	WINTER INDIV-IDUALS	WINTER IND'S PER - 100 TRANS	ANNUAL TOTAL SGHT-INGS	ANNUAL TOTAL INDIV-IDUALS	ANNUAL TOTAL IND'S PER - 100 TRANS
GULF OF MAINE	WEST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CENTRAL	5	87	28	10	179	36	14	315	62	2	40	10	31	621	34
	SOUTHWEST	14	395	198	21	387	69	3	20	9	5	38	21	43	840	74
	SOUTH	22	471	344	7	149	86	4	76	40	3	155	145	36	851	154
	TOTAL	41	953	143	38	715	48	21	411	28	10	233	44	110	2312	65
GEORGES BANK	N. EDGE	2	31	40	12	148	154	0	0	0	0	0	0	14	179	49
	SHOALS	0	0	0	1	12	4	0	0	0	0	0	0	1	12	1
	BANK	5	50	15	18	337	49	0	0	0	0	0	0	23	387	16
	SHELF EDGE	1	7	5	0	0	0	1	300	180	0	0	0	2	307	46
	TOTAL	8	88	15	31	497	52	1	300	45	0	0	0	40	885	28
SOUTHERN NEW ENGLAND	INN. SHELF	3	40	12	0	0	0	0	0	0	1	6	3	4	46	4
	MID. SHELF	6	50	9	2	9	1	3	24	5	2	30	12	13	113	7
	OUT. SHELF	3	129	44	1	20	11	0	0	0	0	0	0	4	149	14
	TOTAL	12	219	22	3	29	4	3	24	2	3	36	5	21	308	8
MID-ATLANTIC BIGHT	INN. SHELF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	MID. SHELF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	OUT. SHELF	1	2	1	1	20	11	1	2	1	0	0	0	3	24	3
	CAROL.CAPE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	1	2	0	1	20	3	1	2	0	0	0	0	3	24	1
COASTAL ZONE	STRATUM 96	1	6	5	0	0	0	0	0	0	2	15	10	3	21	4
	STRATUM 95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	STRATUM 94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	1	6	2	0	0	0	0	0	0	2	15	3	3	21	1
CONTINENTAL SLOPE		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ALL REGIONS COMBINED		63	1268	37	73	1261	22	26	737	16	15	284	11	177	3550	21

6. WHITEBEAKED DOLPHIN *Lagenorhynchus albirostris*

The range of the whitebeaked dolphin *Lagenorhynchus albirostris* extends from approximately Cape Cod waters north to Greenland (Leatherwood et al. 1976; Katona et al. 1983). They are found only in the North Atlantic and are the more northerly distributed of the two *Lagenorhynchus* species, being far more numerous in waters off Canada and Greenland (Sergeant and Fisher 1957; Katona et al. 1977; Whitehead and Glass 1985).

Within the Gulf of Maine sightings occurr most frequently from Cape Cod to Great South Channel north to include Jeffreys Basin (Cetap 1982), between April and November. This species was more common around Cape Cod in the 1950s than at present, and the apparent decline has been accompanied by an increase in sightings of white sided dolphins (Katona et al. 1983).

Monitoring from shipboard surveys

White-beaked dolphin cannot be monitored effectively from any platform in our study area.

7. GRAMPUS _Grampus griseus_

The center of grampus _Grampus griseus_ sightings along the eastern United States occurs along the shelf edge and slope waters from Cape Hatteras north to Georges Bank (36o00N to 41o00N, Figure 11a-11d) during spring, summer and fall (Table 27). They are usually not observed inshore of the 100m isobath (Powers and Payne 1983). Cetap (1982) show that the range contracts to the mid-Atlantic Bight during winter when they move offshore.

The species generally is considered absent from the Gulf of Maine, although individuals and occassionall strandings have occurred.

Monitoring from shipboard surveys

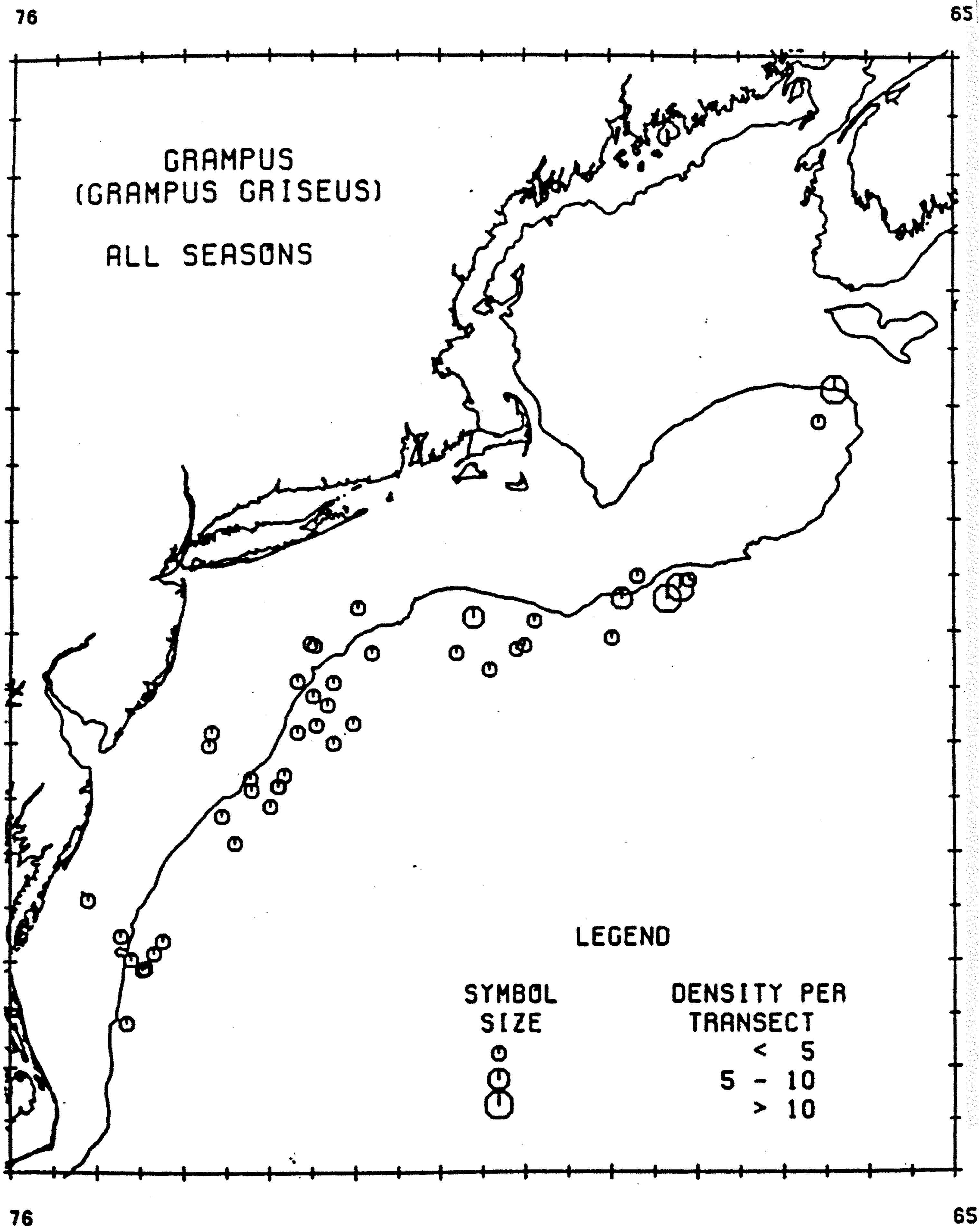
Our data (Table 27) reflects a mid-shelf to slope water distribution from Georges Bank through the mid-Atlantic Bight , with the greatest numbers seen in slope waters, primarily summer and fall. Grampus have been recorded in winter (December -Februuary) only once in our data (Table 27). Monitoring could be best accomplished in summer in midshelf through slope waters.

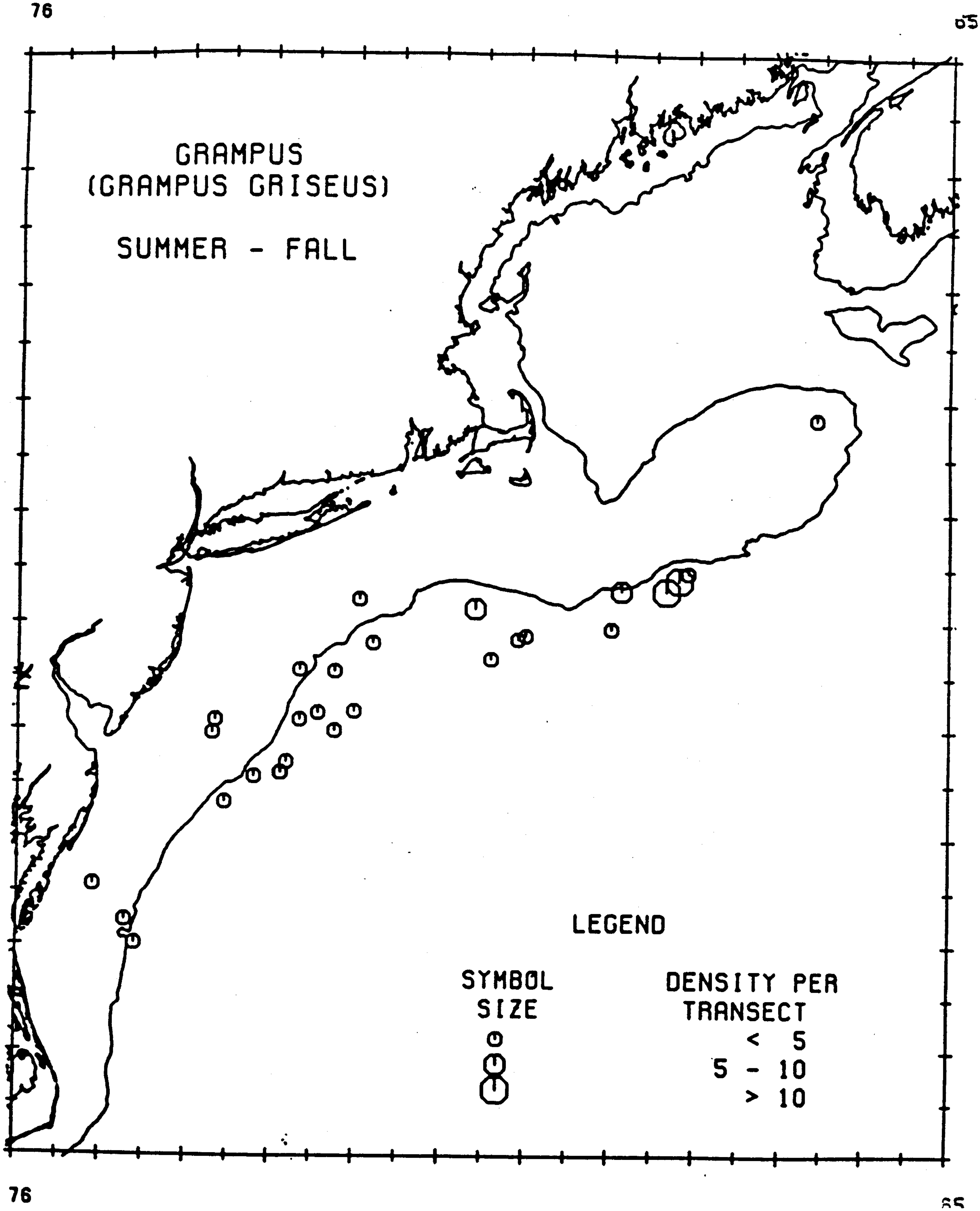
Figure 11a. Distribution of all Risso's dolphin sightings taken during shipboard surveys, for all seasons 1980-1986, in shelf waters of the northeastern United States.

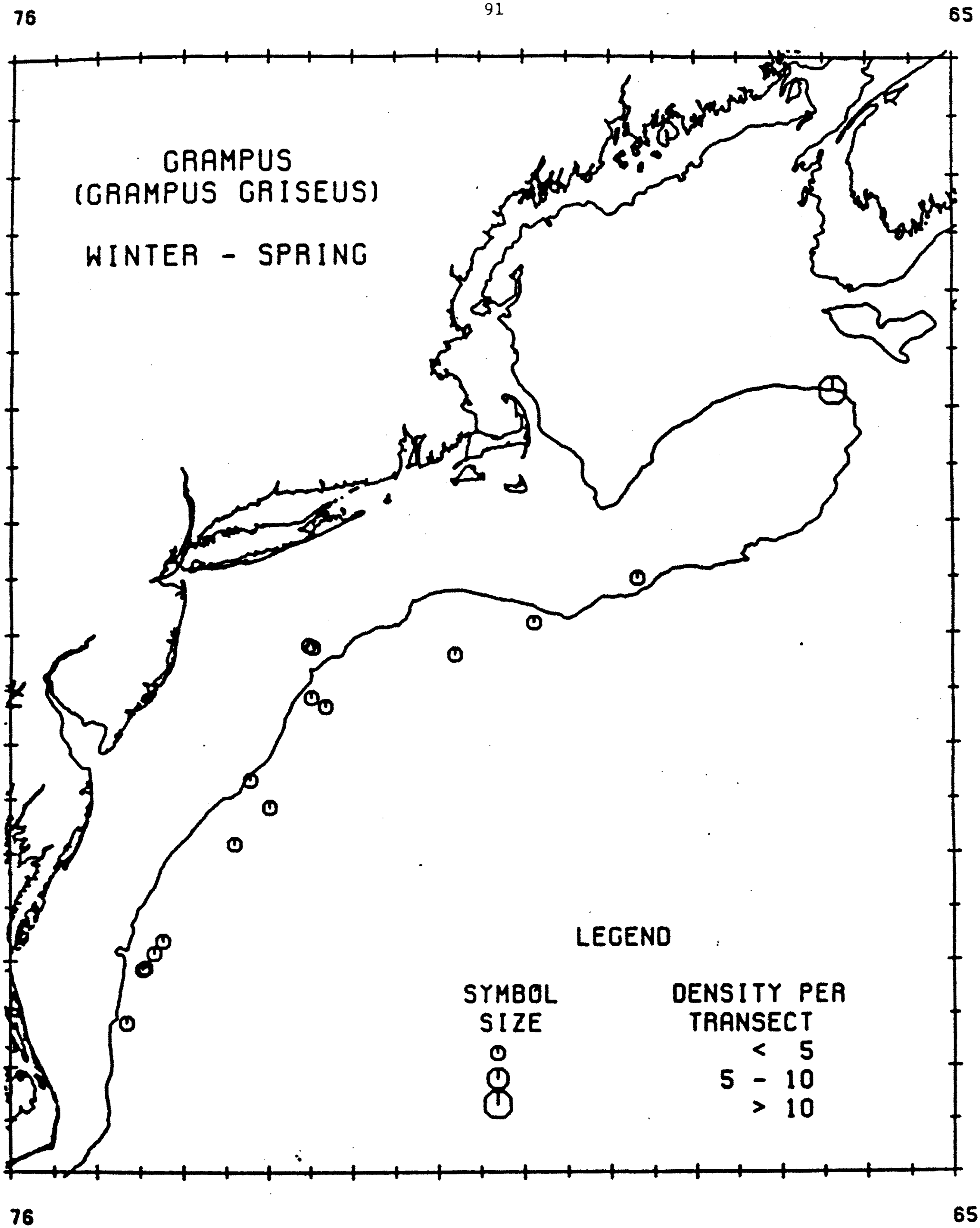
Figure 11b. Distribution of all Risso's dolphin sightings taken during shipboard surveys, for summer and fall 1980-1986, in shelf waters of the northeastern United States.

Figure 11c. Distribution of all Risso's dolphin sightings taken during shipboard surveys, for winter and spring 1980-1986, in shelf waters of the northeastern United States.

Figure 11d. Distribution of all Risso's dolphin sightings taken during shipboard surveys, by season, 1980-1986, in shelf waters of the northeastern United States.


76
65
GRAMPUS
(GRAMPUS GRISEUS)
ALL SEASONS
LEGEND
SYMBOL SIZE
DENSITY PER TRANSECT
< 5
5 - 10
> 10
76
65


76
65
GRAMPUS
(GRAMPUS GRISEUS)
SUMMER - FALL
LEGEND
SYMBOL
SIZE
DENSITY PER
TRANSECT
< 5
5 - 10
> 10
76


76
65
GRAMPUS
(GRAMPUS GRISEUS)
WINTER - SPRING
LEGEND
SYMBOL SIZE
DENSITY PER TRANSECT
< 5
5 - 10
> 10
76
65

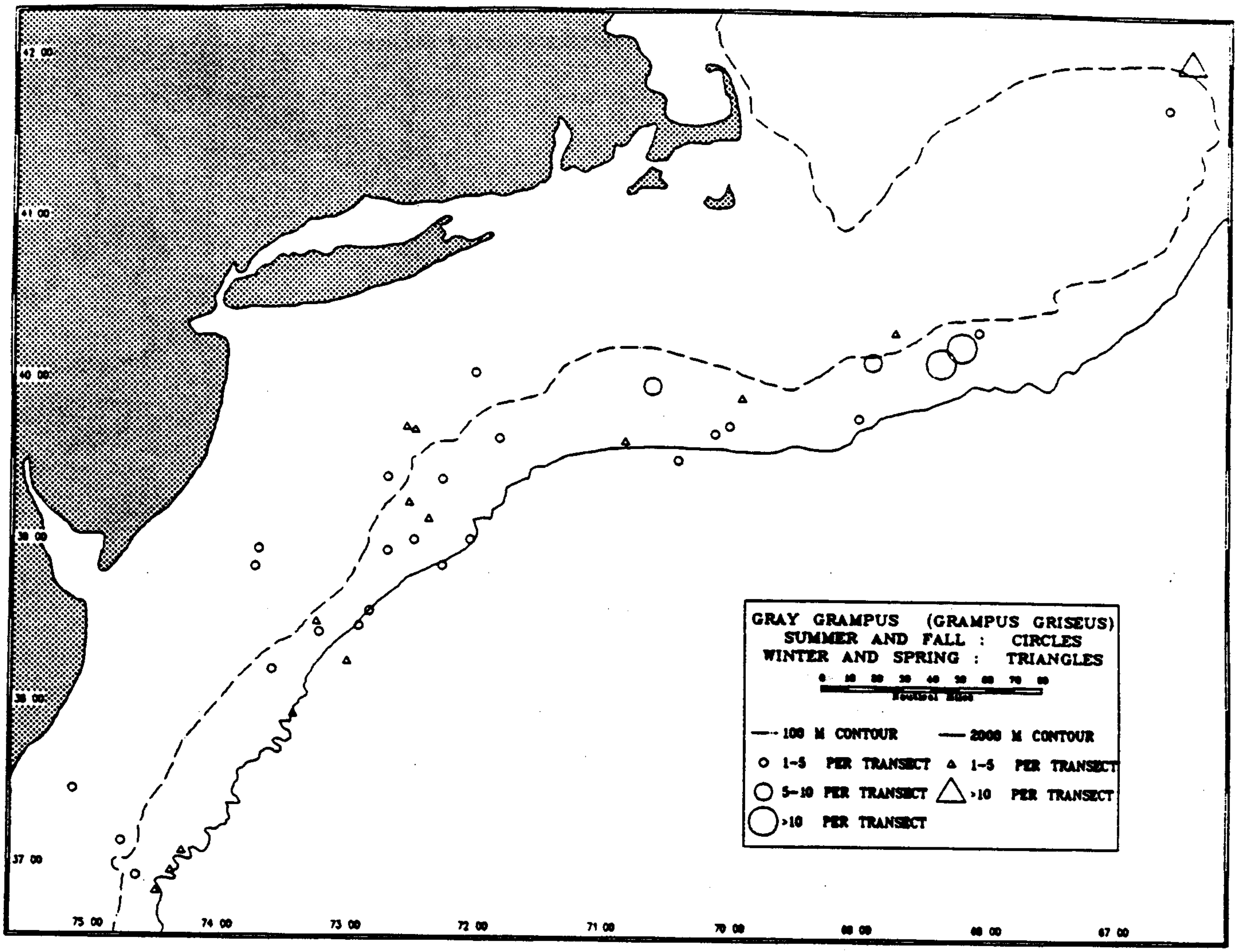

GRAY GRAMPUS (GRAMPUS GRISEUS)
SUMMER AND FALL : CIRCLES
WINTER AND SPRING : TRIANGLES
100 M CONTOUR
2000 M CONTOUR
1-5 PER TRANSECT
1-5 PER TRANSECT
5-10 PER TRANSECT
>10 PER TRANSECT
>10 PER TRANSECT
42 00
41 00
40 00
37 00
75 00
74 00
73 00
72 00
71 00
70 00
67 00

Table 27. Number of sightings, individuals and individuals/100 transects for grampus (Risso's dolphins), 1980 through 1987, all data combined.

REGION	SUB-REGION	SPRING SGHT-INGS	SPRING INDIV-IDUALS	SPRING IND'S PER - 100 TRANS	SUMMER SGHT-INGS	SUMMER INDIV-IDUALS	SUMMER IND'S PER - 100 TRANS	AUTUMN SGHT-INGS	AUTUMN INDIV-IDUALS	AUTUMN IND'S PER - 100 TRANS	WINTER SGHT-INGS	WINTER INDIV-IDUALS	WINTER IND'S PER - 100 TRANS	ANNUAL TOTAL SGHT-INGS	ANNUAL TOTAL INDIV-IDUALS	ANNUAL TOTAL IND'S PER - 100 TRANS
GULF OF MAINE	WEST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CENTRAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SOUTHWEST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SOUTH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GEORGES BANK	N. EDGE	1	40	52	0	0	0	0	0	0	0	0	0	1	40	13
	SHOALS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CENTRAL	1	10	3	2	4	1	1	1	0	0	0	0	4	17	1
	SHELF EDGE	0	0	0	3	110	79	0	0	0	0	0	0	3	110	20
	TOTAL	2	50	14	5	114	20	1	1	0	0	0	0	8	167	8
SOUTHERN NEW ENGLAND	INN. SHELF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	MID. SHELF	2	13	2	5	127	15	1	22	4	0	0	0	8	142	5
	OUT. SHELF	1	8	3	1	3	2	3	40	14	0	0	0	5	51	5
	TOTAL	3	21	2	6	130	5	4	62	4	0	0	0	13	213	3
MID-ATLANTIC BIGHT	INN. SHELF	0	0	0	2	12	1	1	4	1	0	0	0	3	18	1
	MID. SHELF	0	0	0	0	0	0	1	3	1	0	0	0	1	3	0
	OUT. SHELF	1	1	1	2	14	8	5	24	11	1	4	6	9	43	7
	CAROL.CAPE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	1	1	0	4	26	2	7	33	3	1	4	2	13	64	2
COASTAL ZONE	STRATUM 96	0	0	0	1	12	6	0	0	0	0	0	0	1	12	1
	STRATUM 95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	STRATUM 94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	1	12	2	0	0	0	0	0	0	1	12	0
CONTINENTAL SLOPE		8	37	16	9	109	26	3	12	4	0	0	0	20	158	11
ALL REGIONS COMBINED		14	109	4	25	393	7	15	108	2	1	4	0	55	614	3

8. KILLER WHALE <u>Orcinus orca</u>

In the western North Atlantic, killer whales <u>Orcinus orca</u> are widespread, but sporadic. Within the Gulf of Maine, killer whale sightings are most common from mid-July to September in the southwest Gulf of Maine, Cape Cod Bay regions (Katona et al 1976; Cetap 1982). Killer whales are thought to follow the schools of bluefin tuna which move into these waters during late-summer as part of their annual migration. All sightings by Cetap (1982) occurred in shelf waters outside the Gulf of Maine.

<u>Monitoring from shipboard surveys</u>

Killer whales cannot be monitored effectively within our study area.

9. PILOT WHALE Globicephala spp.

The Atlantic pilot whale G. melaena is common from Greenland, Iceland, and the Faeroe Islands (Saemundsson 1939; Sergeant 1968; Kapel 1975; Mercer 1975; Mitchell 1975) south to at least Cape Hatteras (Leatherwood et al. 1976; Katona et al. 1977; Hain et al. 1981; Cetap 1982). In the southern portion of its western North Atlantic range, G. melaena is sympatric with the short-finned pilot whale G. macrorhyncha. The short-finned pilot whale is a more tropical species, common off Florida and in Caribbean waters (Mead 1975; in Katona et al. 1977; Caldwell et al. 1971; Caldwell and Caldwell 1975; Leatherwood et al. 1976) and into the Gulf of Mexico (Fritts and Reynolds 1981). It has stranded as far north as New Jersey (Katona et al. 1977).

From Cape Hatteras to northeast Georges Bank, including the Gulf of Maine, the distribution of pilot whales (although G. melaeana is the most common species in our study area, both species are considered together due to difficulties in field identification) generally follows the shelf edge between the 100m and 1000m contour (data this report, Figure 12a-12d). During mid-winter to spring (December to May), sightings are reported along the shelf edge of the mid-Atlantic and southern New England region (Figure 12c). Throughout spring, sightings increase along the shelf edge and north to, and including, Georges Bank. They are most abundant on Georges Bank from May to October (from Table 28). Therefore mid-winter through spring, pilot whales move onto the shelf edge in the mid-Atlantic region of our study area and continue northward along the edge to Georges Bank. During summer and fall, sightings occur on central Georges Bank north along the northern edge of the Bank, and into the central Gulf of Maine (Figure 12b, 12d). This trend continue as pilot whales move north to the inshore Newfoundland waters by June (Sergeant and Fisher 1957; Sergeant et al. 1970).

Pilot whales are present on Georges Bank summer through winter with scattered sightings along the shelf edge of Georges Bank throughut the year. Sightings are clustered along the northern edge of the Bank and in the Great South Channel in fall. Thus, summer through fall, sightings occur over a broader area of the shelf than during the spring northward movement which principally occurs along the shelf edge.

During late-summer and fall there is also a cluster of sightings near Cape Hatteras. These sightings are possibly G. macrorhyncha during a northern extension of their summer range. Pilot whales are sighted throughout the year from the mid-Atlantic to Georges Bank regions.

Monitoring from shipboard surveys

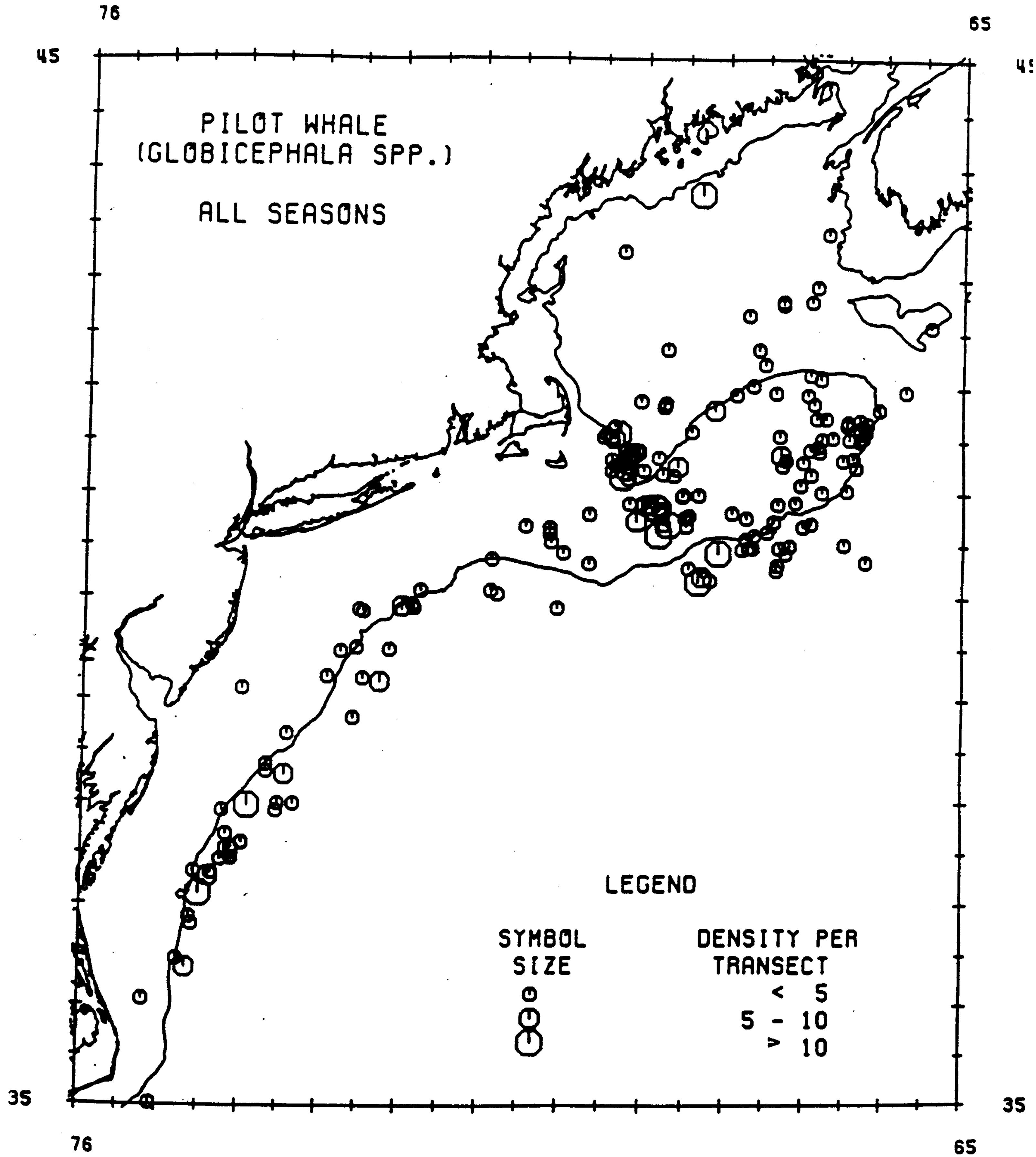
Based on the number of sightings per transects, 1980-1987 (Table 28), and the known distributional patterns of this species, pilot whales can be best monitored during summer and fall, in outer shelf waters from the mid-Atlantic to Georges Bank and extending into the southern and southwestern Gulf of Maine in fall.

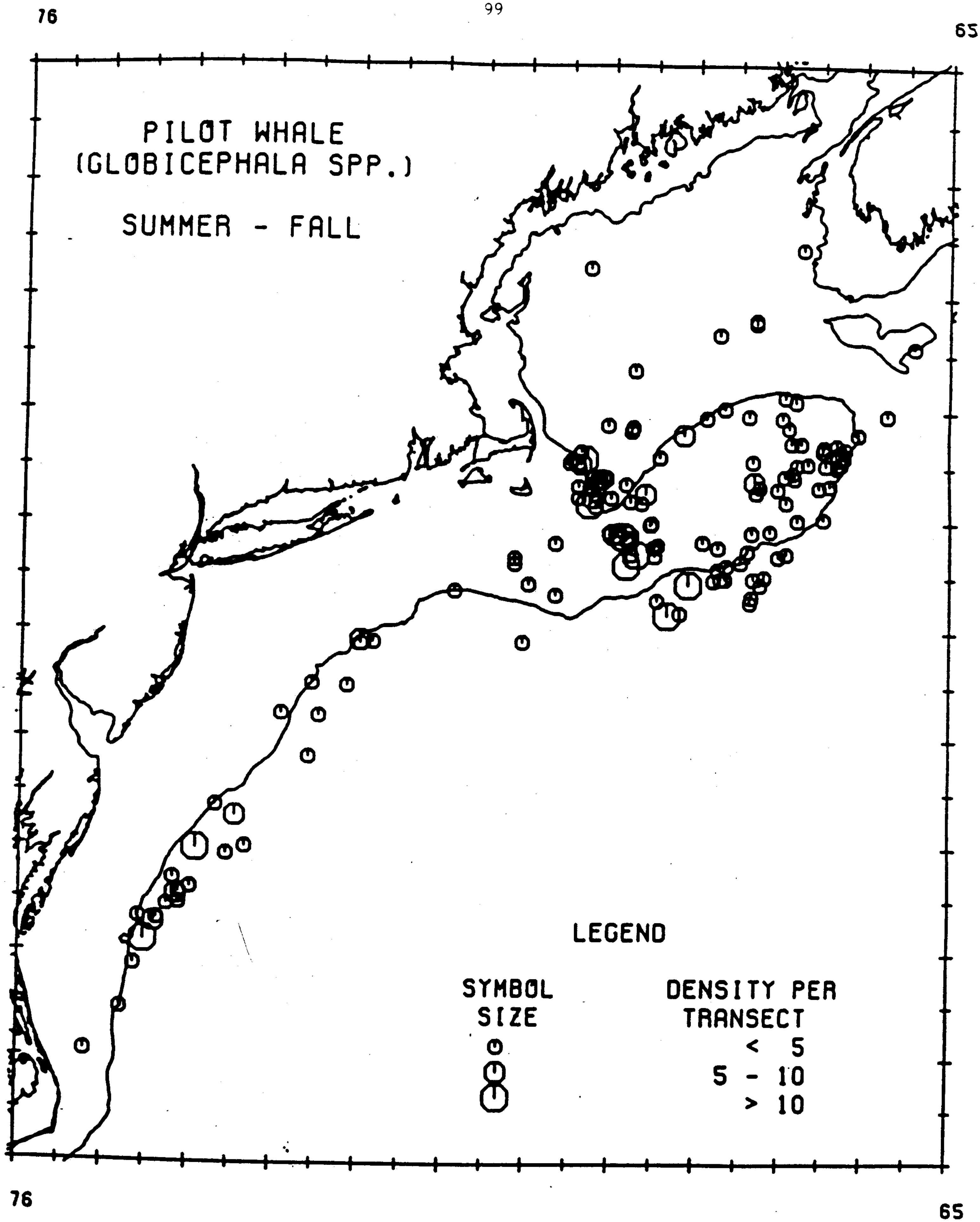
Figure 12a. Distribution of all pilot whale sightings taken during shipboard surveys, for all seasons 1980-1986, in shelf waters of the northeastern United States.

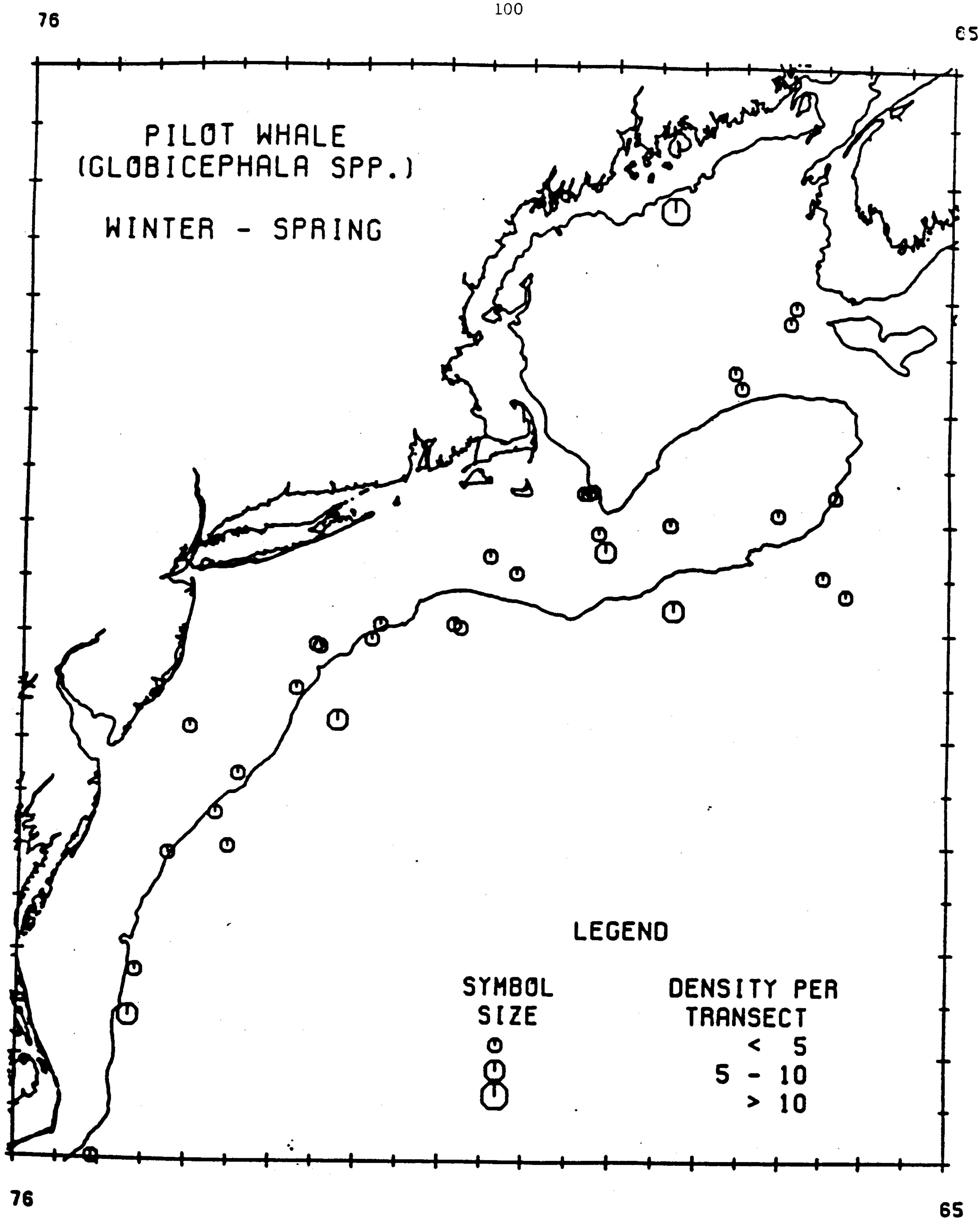
Figure 12b. Distribution of all pilot whale sightings taken during shipboard surveys, for summer and fall 1980-1986, in shelf waters of the northeastern United States.

Figure 12c. Distribution of all pilot whale sightings taken during shipboard surveys, for winter and spring 1980-1986, in shelf waters of the northeastern United States.

Figure 12d. Distribution of all pilot whale sightings taken during shipboard surveys, by season, 1980-1986, in shelf waters of the northeastern United States.


76
65
45
45
PILOT WHALE
(GLOBICEPHALA SPP.)
ALL SEASONS
LEGEND
SYMBOL SIZE
DENSITY PER TRANSECT
< 5
5 - 10
> 10
35
35
76
65


76
65
PILOT WHALE
(GLOBICEPHALA SPP.)
SUMMER - FALL
LEGEND
SYMBOL SIZE
DENSITY PER TRANSECT
< 5
5 - 10
> 10
76
65


76
65
PILOT WHALE
(GLOBICEPHALA SPP.)
WINTER - SPRING
LEGEND
SYMBOL
SIZE
DENSITY PER
TRANSECT
< 5
5 - 10
> 10
76
65

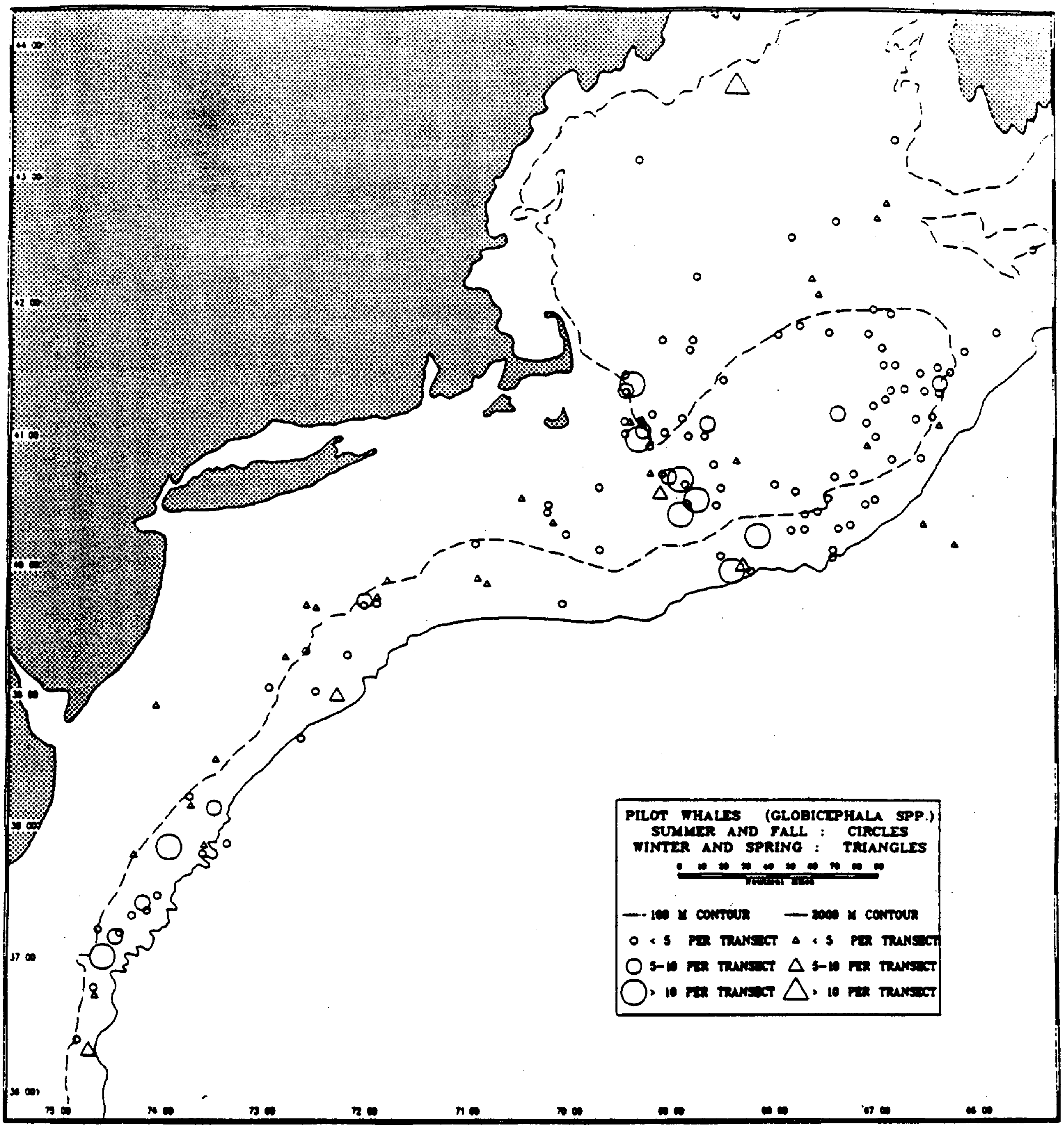

PILOT WHALES (GLOBICEPHALA SPP.)
SUMMER AND FALL : CIRCLES
WINTER AND SPRING : TRIANGLES
100 M CONTOUR
2000 M CONTOUR
< 5 PER TRANSECT
< 5 PER TRANSECT
5-10 PER TRANSECT
5-10 PER TRANSECT
> 10 PER TRANSECT
> 10 PER TRANSECT

Table 28. Number of sightings, individuals and individuals/100 transects for pilot whales, 1980 through 1987, all data combined.

		SPRING			SUMMER			AUTUMN			WINTER			ANNUAL TOTAL		
REGION	SUB-REGION	SGHT-INGS	INDIV-IDUALS	IND'S PER - 100 TRANS	SGHT-INGS	INDIV-IDUALS	IND'S PER - 100 TRANS	SGHT-INGS	INDIV-IDUALS	IND'S PER - 100 TRANS	SGHT-INGS	INDIV-IDUALS	IND'S PER - 100 TRANS	SGHT-INGS	INDIV-IDUALS	IND'S PER - 100 TRANS
GULF OF MAINE	WEST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CENTRAL	2	3	1	1	5	1	7	48	9	2	60	15	12	116	7
	SOUTHWEST	0	0	0	4	49	9	12	216	97	3	27	15	19	292	30
	SOUTH	0	0	0	4	69	40	10	73	38	0	0	0	14	142	20
	TOTAL	2	3	0	9	123	12	29	337	36	5	87	7	45	550	14
GEORGES BANK	N. EDGE	0	0	0	4	45	47	4	25	22	0	0	0	8	70	17
	SHOALS	1	4	2	10	135	46	5	27	12	0	0	0	16	166	15
	CENTRAL	2	15	4	30	250	37	10	97	24	0	0	0	42	362	16
	SHELF EDGE	1	62	48	2	20	14	10	172	103	0	0	0	13	254	41
	TOTAL	4	81	14	46	450	36	29	321	40	0	0	0	79	852	22
SOUTHERN NEW ENGLAND	INN. SHELF	2	20	6	3	11	2	2	27	6	0	0	0	7	58	3
	MID. SHELF	17	170	31	2	7	1	9	145	28	2	39	15	30	361	19
	OUT. SHELF	2	24	8	1	4	2	3	12	4	2	13	26	8	53	10
	TOTAL	21	214	15	6	22	1	14	184	13	4	52	14	45	472	11
MID-ATLANTIC BIGHT	INN. SHELF	0	0	0	1	1	0	0	0	0	1	3	1	2	4	0
	MID. SHELF	4	106	35	3	7	2	0	0	0	1	6	6	8	119	10
	OUT. SHELF	2	9	5	12	282	162	2	123	59	0	0	0	16	414	56
	CAROL.CAPE	1	12	12*	0	0	0	0	0	0	0	0	0	1	12	3
	TOTAL	7	127	13	16	290	41	2	123	15	2	9	2	27	549	18
COASTAL ZONE	STRATUM 96	0	0	0	0	0	0	0	0	0	1	5	3	1	5	1
	STRATUM 95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	STRATUM 94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	1	5	1	1	5	0
CONTINENTAL SLOPE		4	50	22	6	58	14	1	5	2	0	0	0	11	113	9
ALL REGIONS COMBINED		38	475	9	83	943	20	75	970	21	12	153	4	208	2541	14

10. HARBOR PORPOISE <u>Phocoena phocoena</u>

The harbor porpoise Phocoena phocoena is locally abundant in the Bay of Fundy and northern Gulf of Maine in summer, where they are classified as "abundant" in comparison with all other areas examined (Gaskin 1977). Prescott and Fiorelli (1980) indicated that the northern Gulf of Maine and the Bay of Fundy might support as much as 80% of the total summer populations south of the Gulf of St. Lawrence. During the high abundance levels of summer in the northern Gulf of Maine (Figures 13a, 13b), sightings throughout the southwestern Gulf of Maine (Jeffreys Ledge and Stellwagen Bank) and Cape Cod Bay are rare. Sightings decrease throughout fall in the lower Bay of Fundy-upper Gulf of Maine.

In the winter, the distribution of harbor porpoise shifts markedly to the south. Sightings are scattered throughout the lower Gulf of Maine and Georges Bank and overall numbers are drastically reduced. Sightings south of 40o00N latitude in coastal waters increase during winter and early spring (from Table 22).

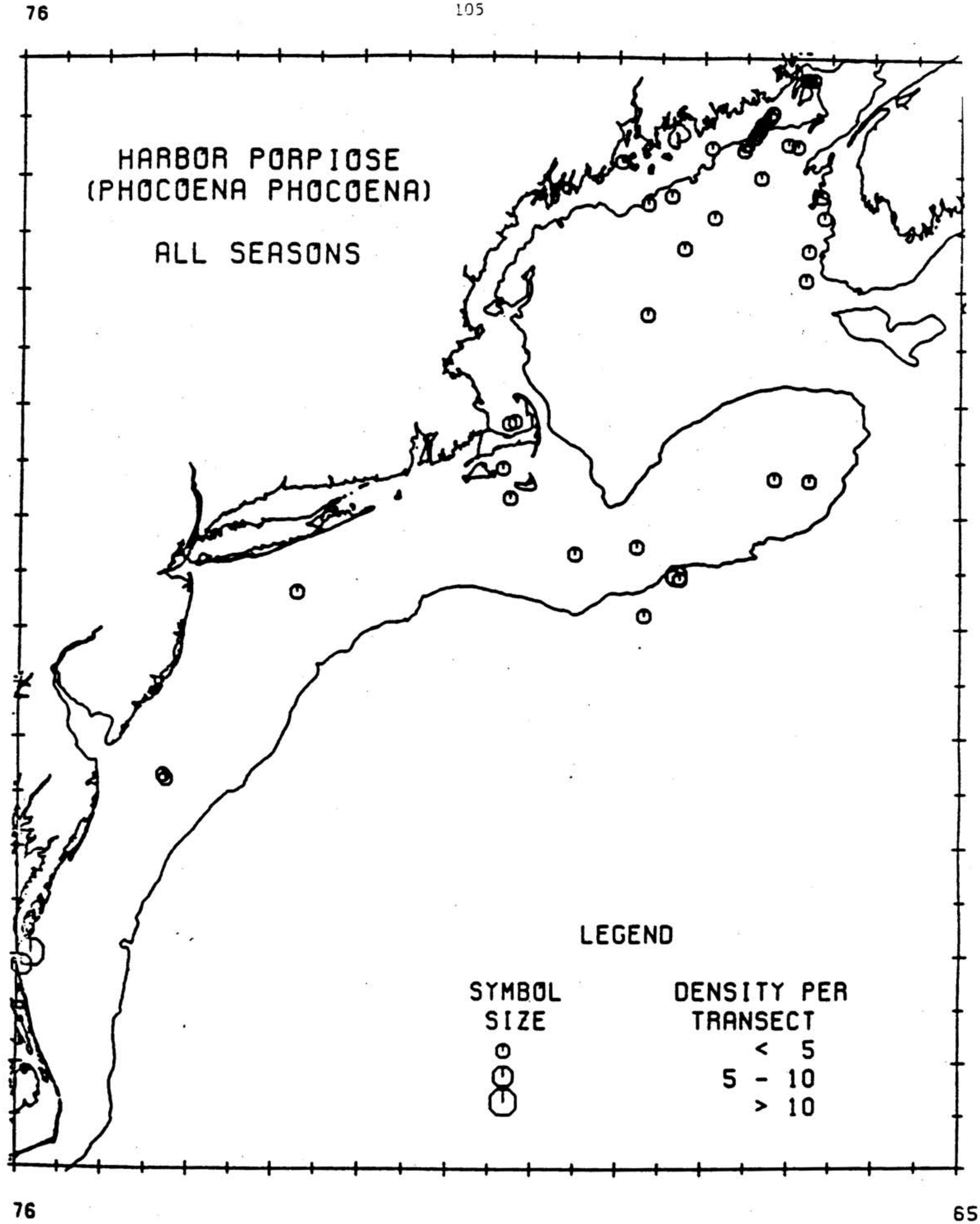
By mid-spring sightings of harbor porpoise are again concentrated in the southwest Gulf of Maine-Great South Channel, Jeffreys Ledge and in portions of coastal Maine.

<u>Monitoring from shipboard surveys</u>

Harbor porpoise could best be monitored by dedicated surveys during summer and in coastal Maine waters. Standardized surveys, i.e trawl, MARMAP, do not provide a platform that enables harbor porpoise to be detected, therefore monitored.

Figure 13a. Distribution of all harbor porpoise sightings taken during shipboard surveys, for all seasons 1980-1986, in shelf waters of the northeastern United States.

Figure 13b. Distribution of all harbor porpoise sightings taken during shipboard surveys, by season, 1980-1986, in shelf waters of the northeastern United States.


76
HARBOR PORPIOSE
(PHOCOENA PHOCOENA)
ALL SEASONS
LEGEND
SYMBOL SIZE
DENSITY PER TRANSECT
< 5
5 - 10
> 10
76
65

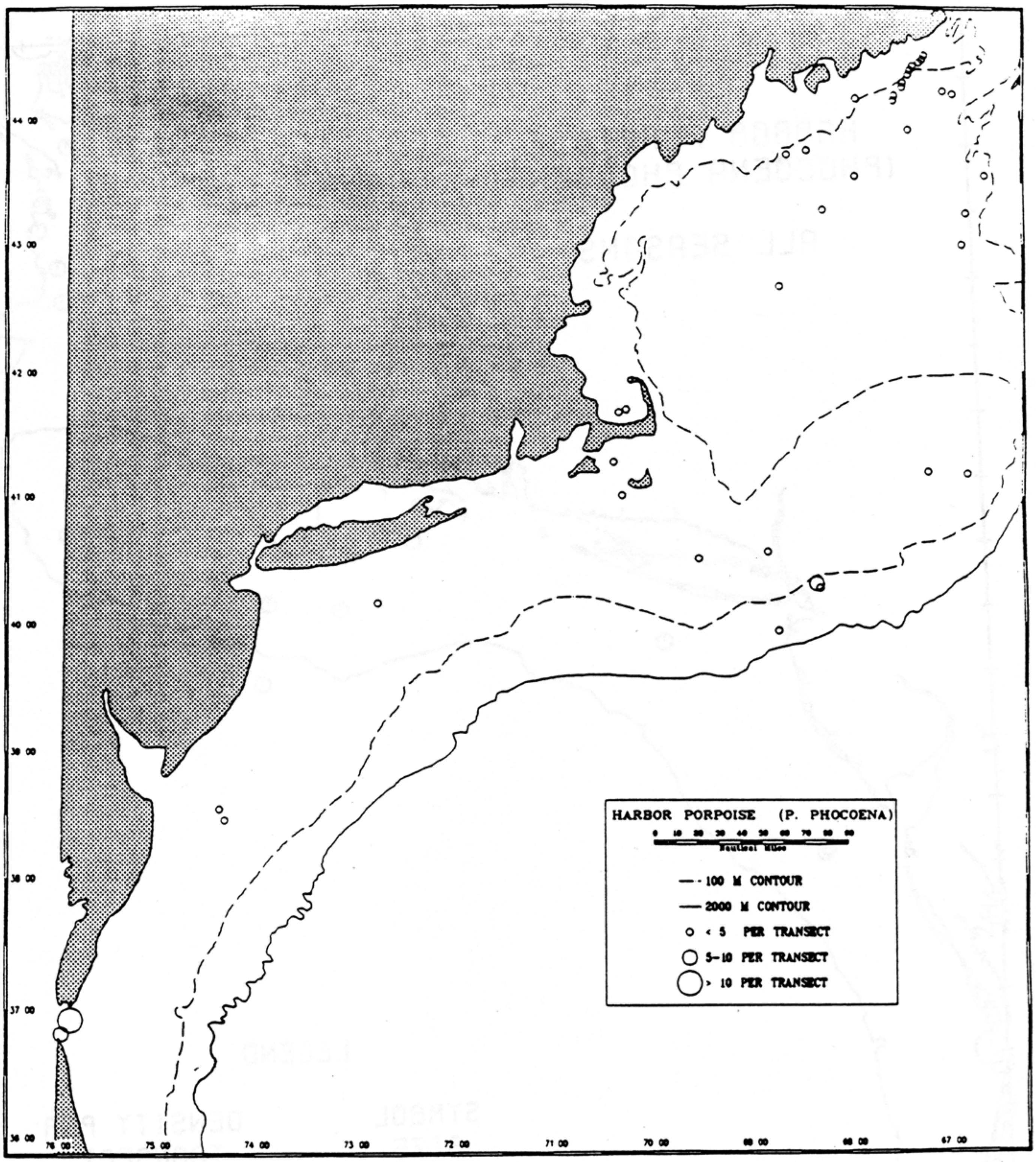

HARBOR PORPOISE (P. PHOCOENA)
0 10 20 30 40 50 60 70 80 90
Nautical Miles
100 M CONTOUR
2000 M CONTOUR
< 5 PER TRANSECT
5-10 PER TRANSECT
> 10 PER TRANSECT
44 00
43 00
42 00
41 00
40 00
39 00
38 00
37 00
36 00
76 00
75 00
74 00
73 00
72 00
71 00
70 00
69 00
68 00
67 00

Table 29. Number of sightings, individuals and individuals/100 transects for harbor porpoise, 1980 through 1987, all data combined.

REGION	SUB-REGION	SPRING SGHT-INGS	SPRING INDIV-IDUALS	SPRING IND'S PER - 100 TRANS	SUMMER SGHT-INGS	SUMMER INDIV-IDUALS	SUMMER IND'S PER - 100 TRANS	AUTUMN SGHT-INGS	AUTUMN INDIV-IDUALS	AUTUMN IND'S PER - 100 TRANS	WINTER SGHT-INGS	WINTER INDIV-IDUALS	WINTER IND'S PER - 100 TRANS	ANNUAL TOTAL SGHT-INGS	ANNUAL TOTAL INDIV-IDUALS	ANNUAL TOTAL IND'S PER - 100 TRANS
GULF OF MAINE	WEST	0	0	0	0	0	0	0	0	0	1	2	3	1	2	1
	CENTRAL	3	13	4	6	31	6	1	8	2	0	0	0	10	52	3
	SOUTHWEST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SOUTH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	3	13	1	6	31	2	1	8	0	1	2	1	11	54	1
GEORGES BANK	N. EDGE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SHOALS	0	0	0	1	2	1	0	0	0	0	0	0	1	2	0
	CENTRAL	0	0	0	4	8	1	1	10	2	0	0	0	5	18	1
	SHELF EDGE	1	1	1	0	0	0	1	1	1	0	0	0	2	2	0
	TOTAL	1	1	0	5	10	0	2	11	1	0	0	0	8	22	0
SOUTHERN NEW ENGLAND	INN. SHELF	2	3	1	0	0	0	0	0	0	0	0	0	2	3	0
	MID. SHELF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	OUT. SHELF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	2	3	0	0	0	0	0	0	0	0	0	0	2	3	0
MID-ATLANTIC BIGHT	INN. SHELF	2	9	2	0	0	0	0	0	0	0	0	0	2	9	0
	MID. SHELF	0	0	0	1	2	0	0	0	0	0	0	0	1	2	0
	OUT. SHELF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CAROL.CAPE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	2	9	0	1	2	0	0	0	0	0	0	0	3	11	0
COASTAL ZONE	STRATUM 96	3	9	8	0	0	0	0	0	0	0	0	0	3	9	2
	STRATUM 95	0	0	0	1	50	21	0	0	0	0	0	0	1	50	5
	STRATUM 94	0	0	0	1	15	12	0	0	0	0	0	0	1	15	3
	TOTAL	3	9	3	2	65	11	0	0	0	0	0	0	5	74	3
CONTINENTAL SLOPE		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ALL REGIONS COMBINED		11	35	1	14	108	2	3	19	0	1	2	0	29	164	1

11. SPERM WHALE _Physeter_ _macrocephalus_

The distribution of this species in all seasons off the east coast of the United States generally is along the shelf edge and seaward into slope waters (data this report, Figures 14a-14d, Table 30). In winter, sperm whales are concentrated east of Cape Hatteras (Cetap 1982). Between May and November, sperm whales move along the shelf edge south of Nantucket and around the perimeter of Georges Bank (Payne et al. 1984). Within the Gulf of Maine in the fall, sightings occur in the deepwater of the Northeast Channel between northeast Georges Bank and Browns Bank (Figure 14b, 14d). A fishery based out of Nova Scotia worked in slope waters seaward of the Northeast Channel (Mitchell 1975b; Sutcliffe and Brodie 1977). These on-shelf sightings are temporally correlated with intrusions of warmer slope water onto the shelf, as well as to movements of sauid into shallower shelf waters. Incidental sightings and strandings occur sporadically within the Gulf of Maine, including Cape Cod waters (Katona et al. 1983).

Monitoring from shipboard surveys

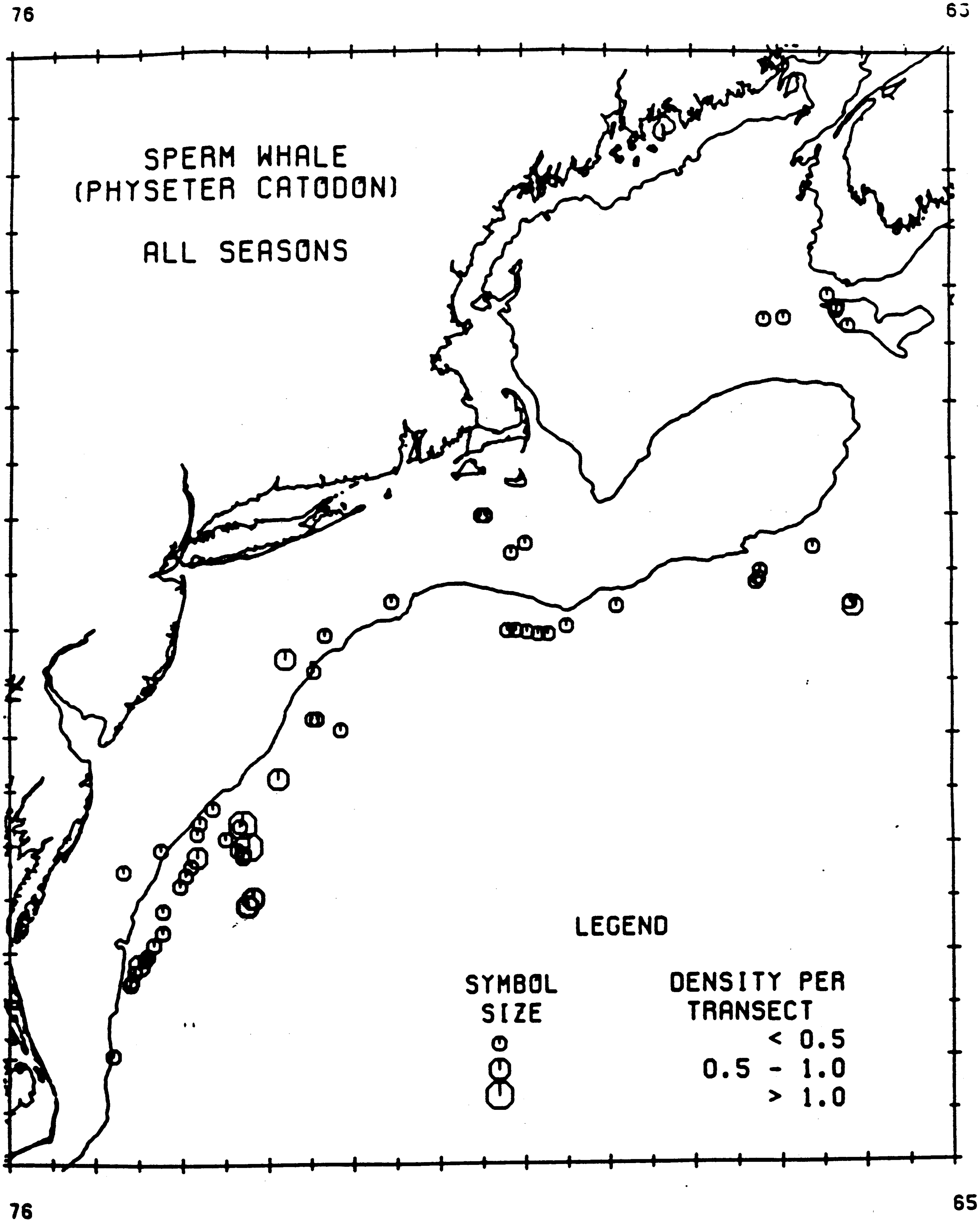
Based on the number of sightings per transect (Table 30), sperm whales can be best monitored in mid-shelf to slope waters of the mid-Atlantic to southern New England.

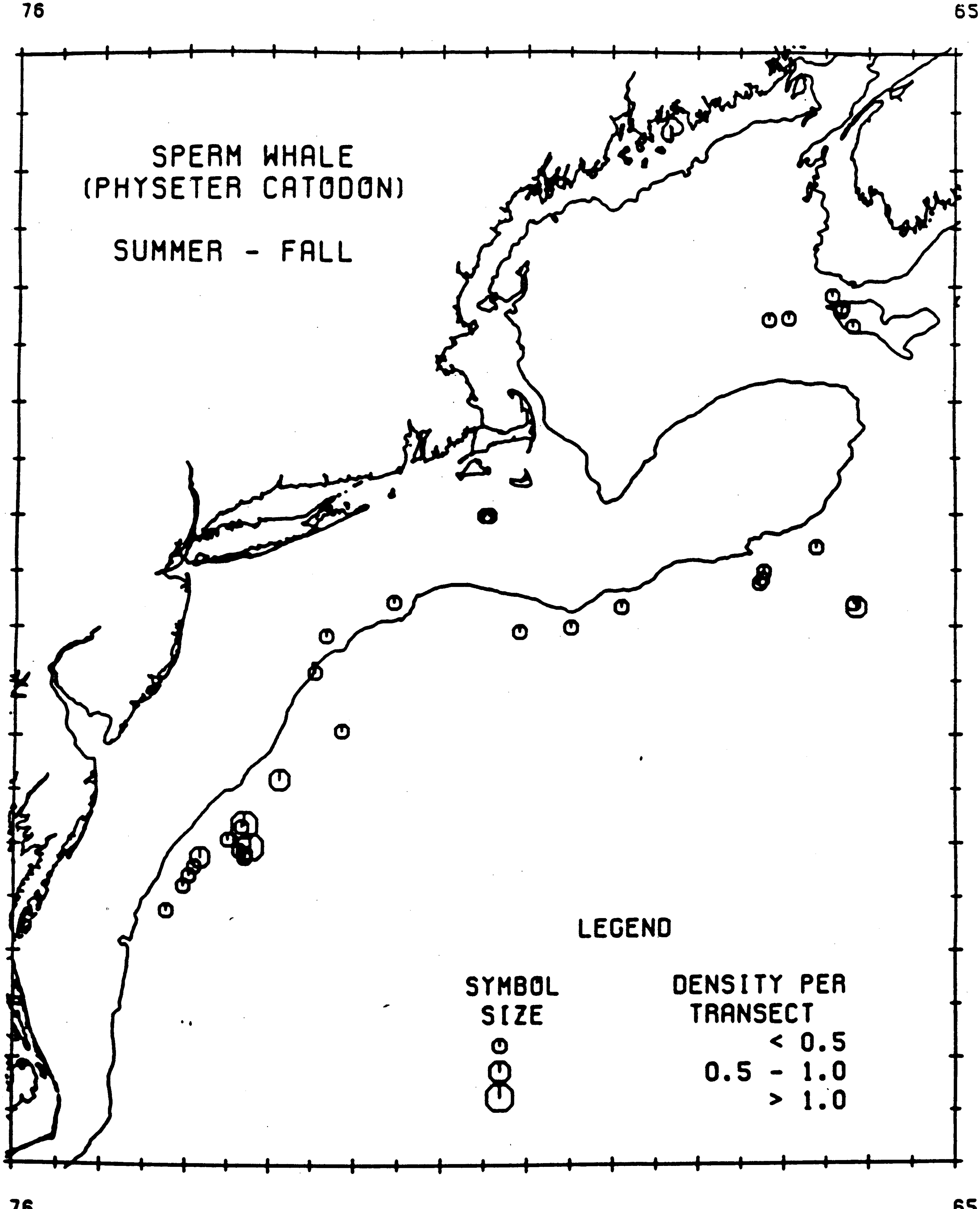
Figure 14a. Distribution of all sperm whale sightings taken during shipboard surveys, for all seasons 1980-1986, in shelf waters of the northeastern United States.

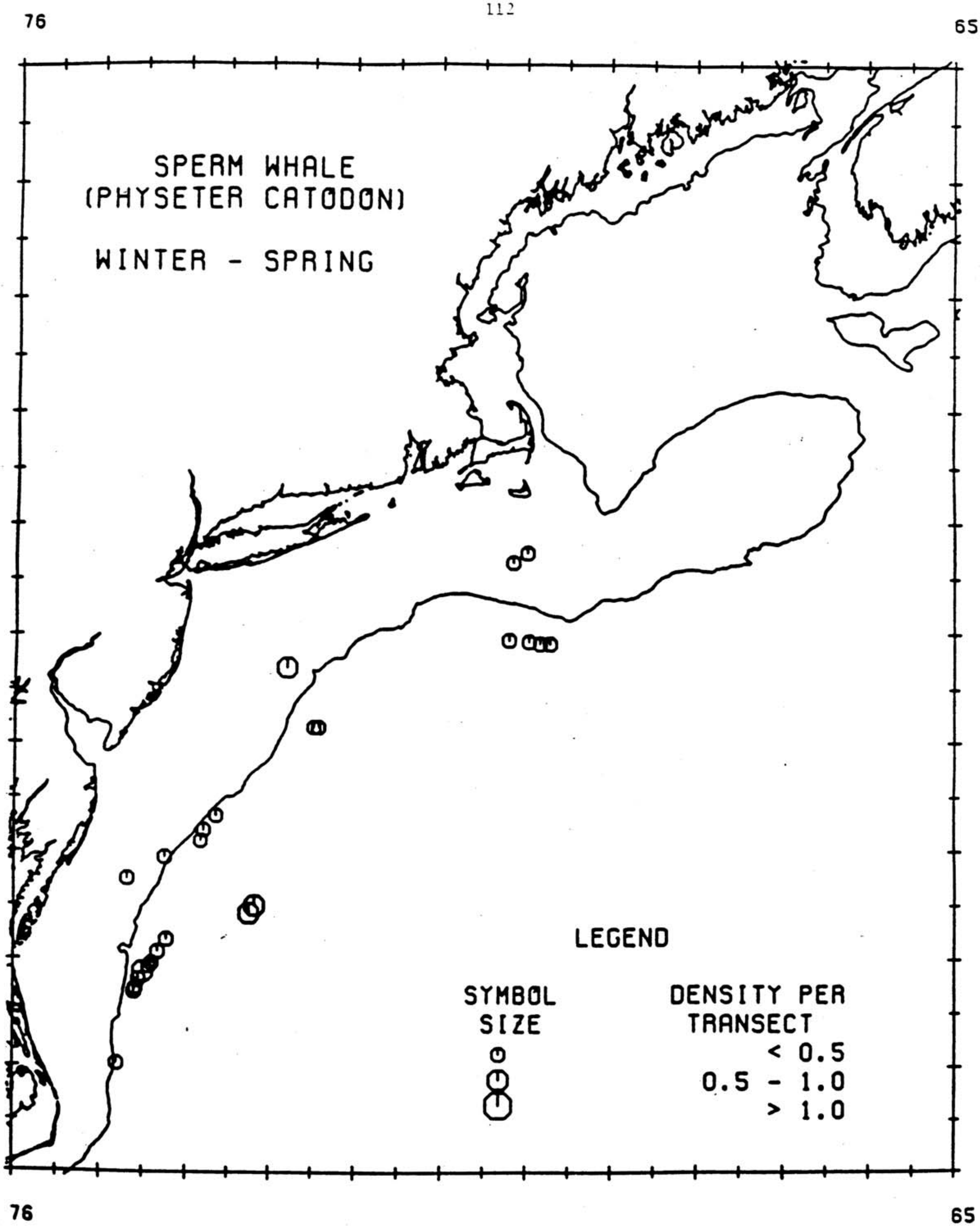
Figure 14b. Distribution of all sperm whale sightings taken during shipboard surveys, for summer and fall 1980-1986, in shelf waters of the northeastern United States.

Figure 14c. Distribution of all sperm whale sightings taken during shipboard surveys, for winter and spring 1980-1986, in shelf waters of the northeastern United States.

Figure 14d. Distribution of all sperm whale sightings taken during shipboard surveys, by season, 1980-1986, in shelf waters of the northeastern United States.


76
SPERM WHALE
(PHYSETER CATODON)
ALL SEASONS
LEGEND
SYMBOL SIZE
DENSITY PER TRANSECT
< 0.5
0.5 - 1.0
> 1.0
76
65


76
65
SPERM WHALE
(PHYSETER CATODON)
SUMMER - FALL
LEGEND
SYMBOL SIZE
DENSITY PER TRANSECT
< 0.5
0.5 - 1.0
> 1.0
76
65


76
65
SPERM WHALE
(PHYSETER CATODON)
WINTER - SPRING
LEGEND
SYMBOL
SIZE
DENSITY PER
TRANSECT
< 0.5
0.5 - 1.0
> 1.0
76
65

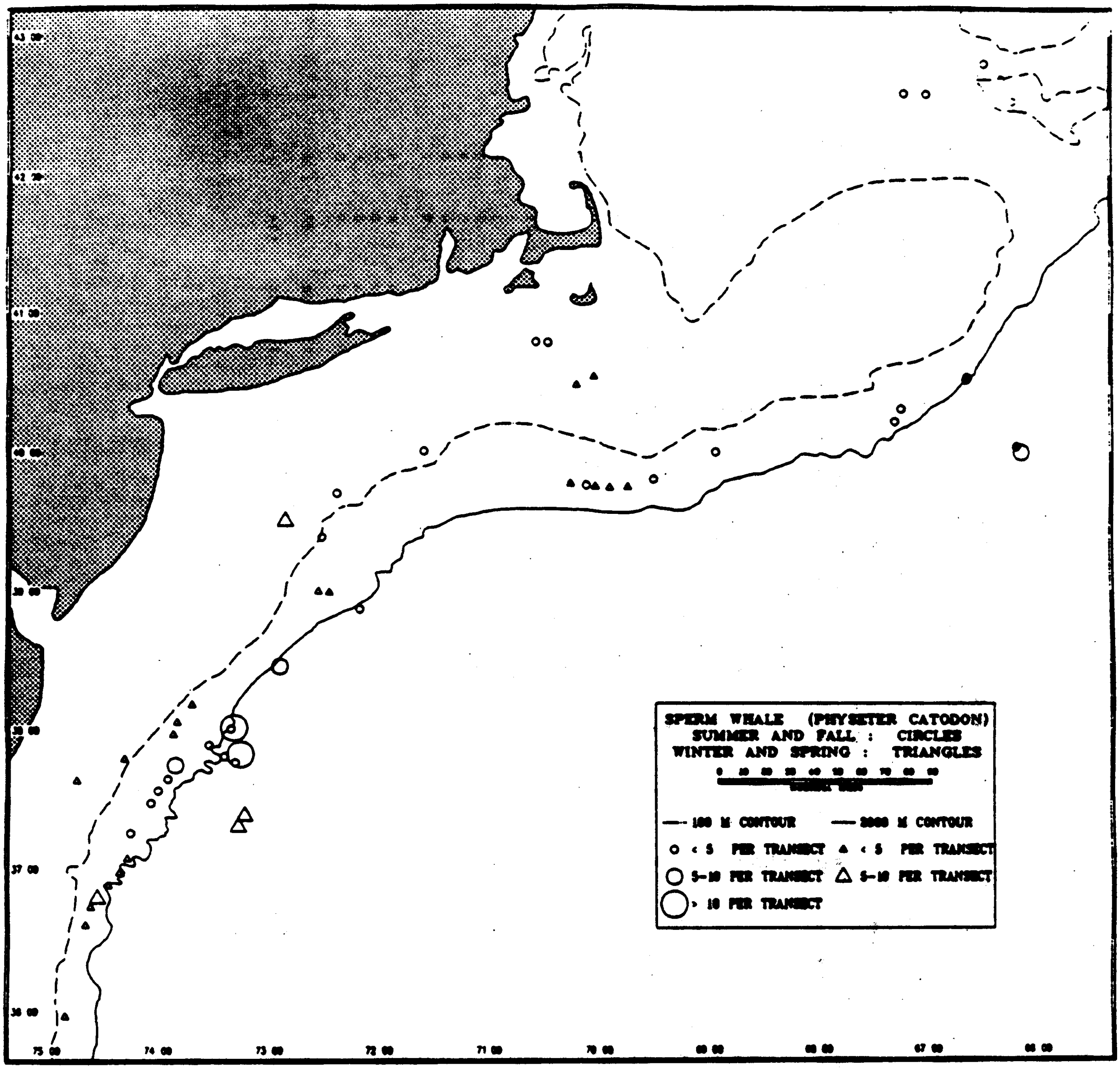

SPERM WHALE (PHYSETER CATODON)
SUMMER AND FALL : CIRCLES
WINTER AND SPRING : TRIANGLES
100 M CONTOUR
2000 M CONTOUR
< 5 PER TRANSECT
< 5 PER TRANSECT
5-10 PER TRANSECT
5-10 PER TRANSECT
> 10 PER TRANSECT

Table 30. Number of sightings, individuals and individuals/100 transects for sperm whales, 1980 through 1987, all data combined.

REGION	SUB-REGION	SPRING SGHT-INGS	SPRING INDIV-IDUALS	SPRING IND'S PER - 100 TRANS	SUMMER SGHT-INGS	SUMMER INDIV-IDUALS	SUMMER IND'S PER - 100 TRANS	AUTUMN SGHT-INGS	AUTUMN INDIV-IDUALS	AUTUMN IND'S PER - 100 TRANS	WINTER SGHT-INGS	WINTER INDIV-IDUALS	WINTER IND'S PER - 100 TRANS	ANNUAL TOTAL SGHT-INGS	ANNUAL TOTAL INDIV-IDUALS	ANNUAL TOTAL IND'S PER - 100 TRANS
GULF OF MAINE	WEST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CENTRAL	0	0	0	0	0	0	2	3	1	0	0	0	2	3	0
	SOUTHWEST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SOUTH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	2	3	0	0	0	0	2	3	0
GEORGES BANK	N. EDGE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SHOALS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CENTRAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SHELF EDGE	0	0	0	3	3	2	0	0	0	0	0	0	3	3	1
	TOTAL	0	0	0	3	3	1	0	0	0	0	0	0	3	3	0
SOUTHERN NEW ENGLAND	INN. SHELF	0	0	0	0	0	0	2	2	0	2	5	3	4	7	1
	MID. SHELF	0	0	0	2	2	0	0	0	0	1	4	2	3	6	0
	OUT. SHELF	5	7	2	1	1	1	0	0	0	0	0	0	6	8	1
	TOTAL	5	7	1	3	3	0	2	2	0	3	9	1	13	21	1
MID-ATLANTIC BIGHT	INN. SHELF	1	3	1	0	0	0	0	0	0	0	0	0	1	3	0
	MID. SHELF	1	2	1	0	0	0	0	0	0	0	0	0	1	2	0
	OUT. SHELF	0	0	0	0	0	0	0	0	0	3	5	8	3	5	2
	CAROL.CAPE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	2	5	0	0	0	0	0	0	0	3	5	2	5	10	1
COASTAL ZONE	STRATUM 96	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	STRATUM 95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	STRATUM 94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CONTINENTAL SLOPE		8	19	8	20	68	16	0	0	0	0	0	0	28	87	4
ALL REGIONS COMBINED		15	31	1	26	74	1	4	5	0	4	14	1	51	124	1

12. MINKE WHALE *Balaenoptera acutorostrata*

The minke whale *Balaenoptera acutorostrata* occupies wide regions of the shelf, especially in spring and summer (data this report, Figures 15a-d). The area of greatest abundance as described by CETAP (1982) is a U-shaped area extending east from Montauk Point, Long Island, southeast of Nantucket Shoals to the Great South Channel, then northward along the 100m contour outside Cape Cod to Stellwagen Bank and Jeffreys Ledge. Minke whales are commonly observed in the Stellwagen /southern Jeffreys Ledge area from March until November. Overwintering may also occur in this area. Aggregations of minke whales often are in the immediate vicinity of fin whales *B. physalus*. Sightings south of Nova Scotia from mid-April to October generally are concentrated in this region or along the northern edge of Georges Bank (from Table 31). In late summer their range extends into the northern Gulf of Maine-lower Bay of Fundy. Their range is contracted in fall and winter. Although winter sightings occur in the mid-Atlantic during winter (Table 31), winter sightings in shelf waters southeast of Nantucket (south of 40o00'N) are rare.

Monitoring from shipboard surveys

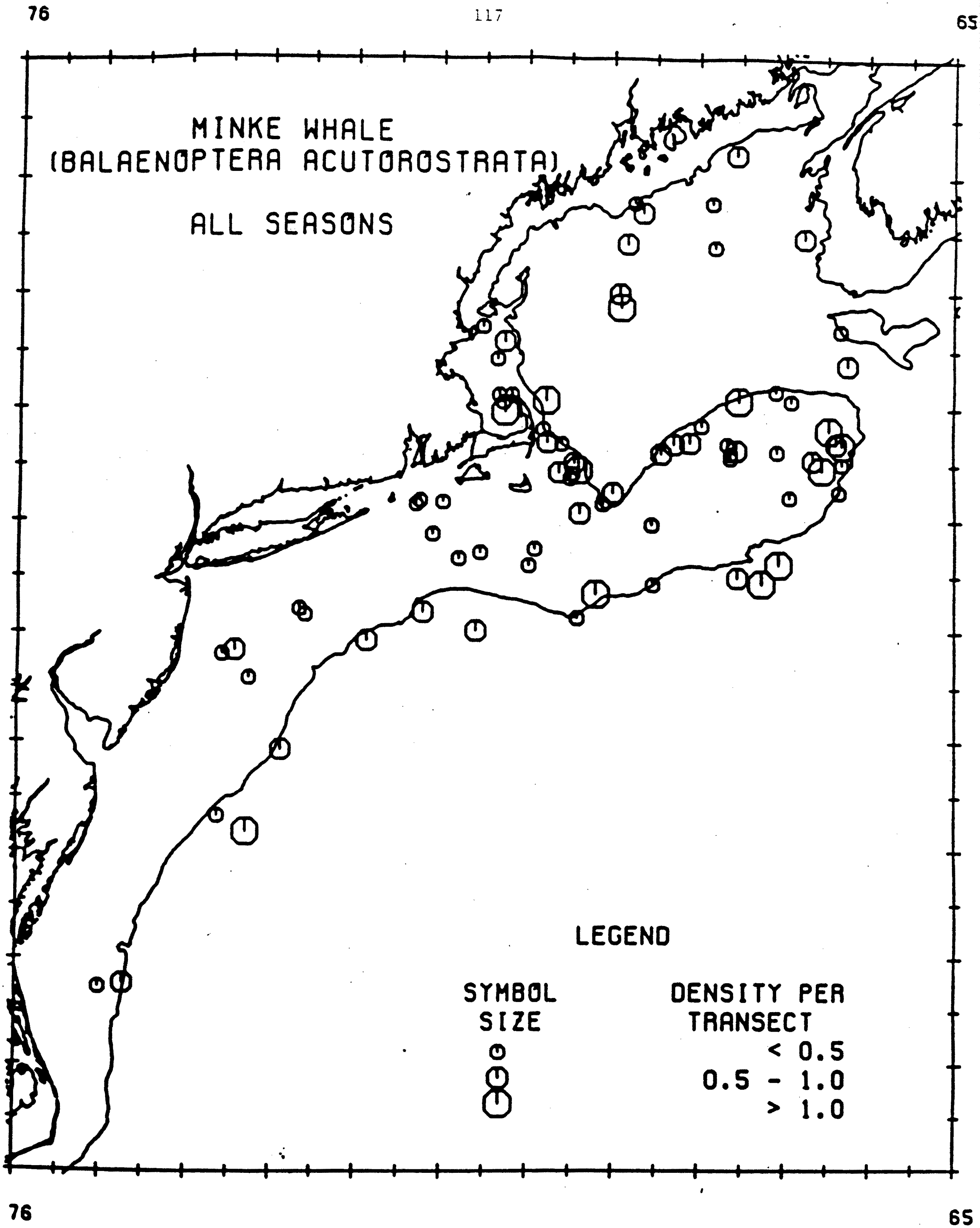
Minke whales are generally distributed sympatrically with fin whales. The areas of greatest sightings per effort occur from the south-southwestern Gulf of Maine eastward along the northern edge of Georges Bank (Table 31). Therefore monitoring would be most effective in these areas in spring through fall.

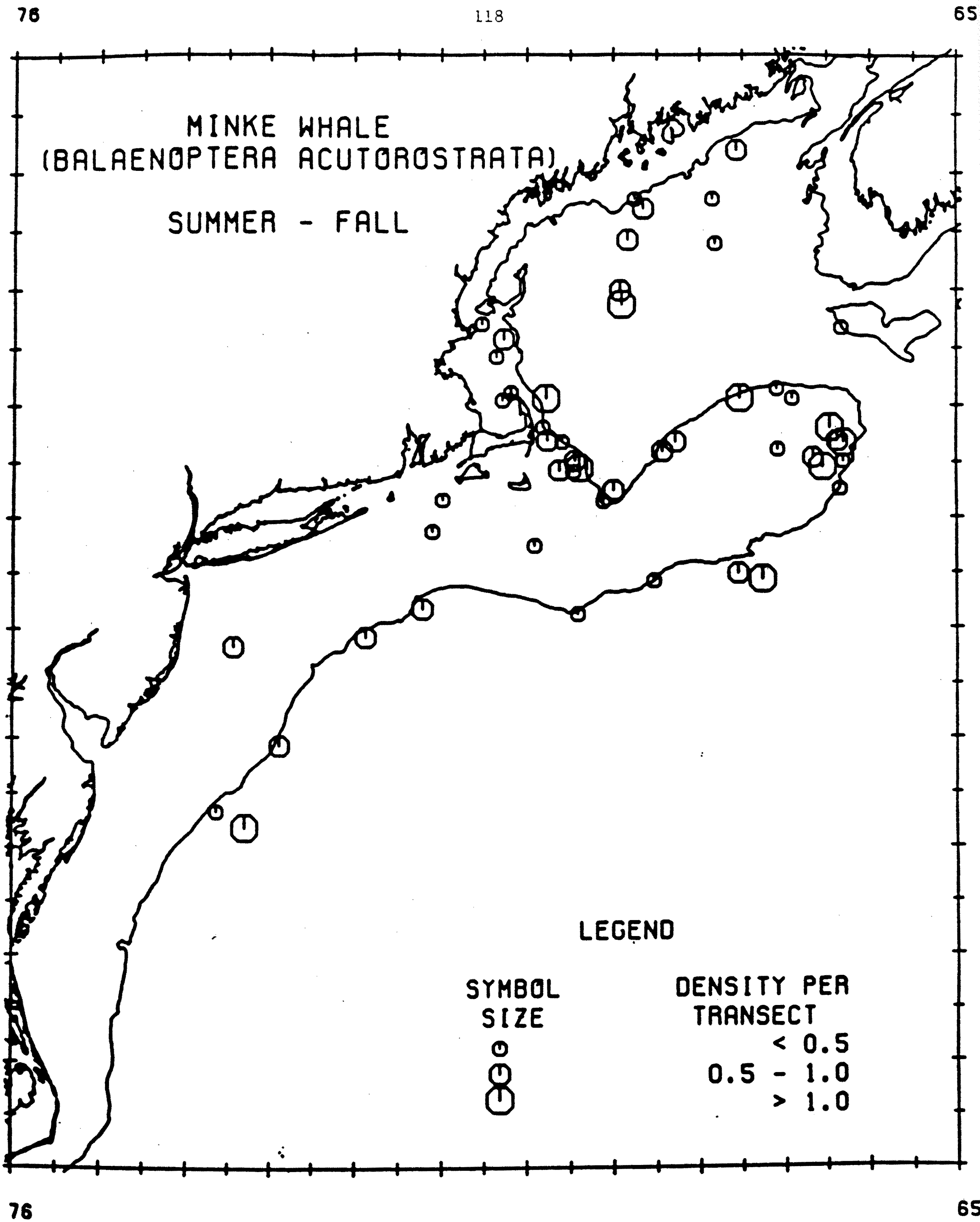
Figure 15a. Distribution of all minke whale sightings taken during shipboard surveys, for all seasons 1980-1986, in shelf waters of the northeastern United States.

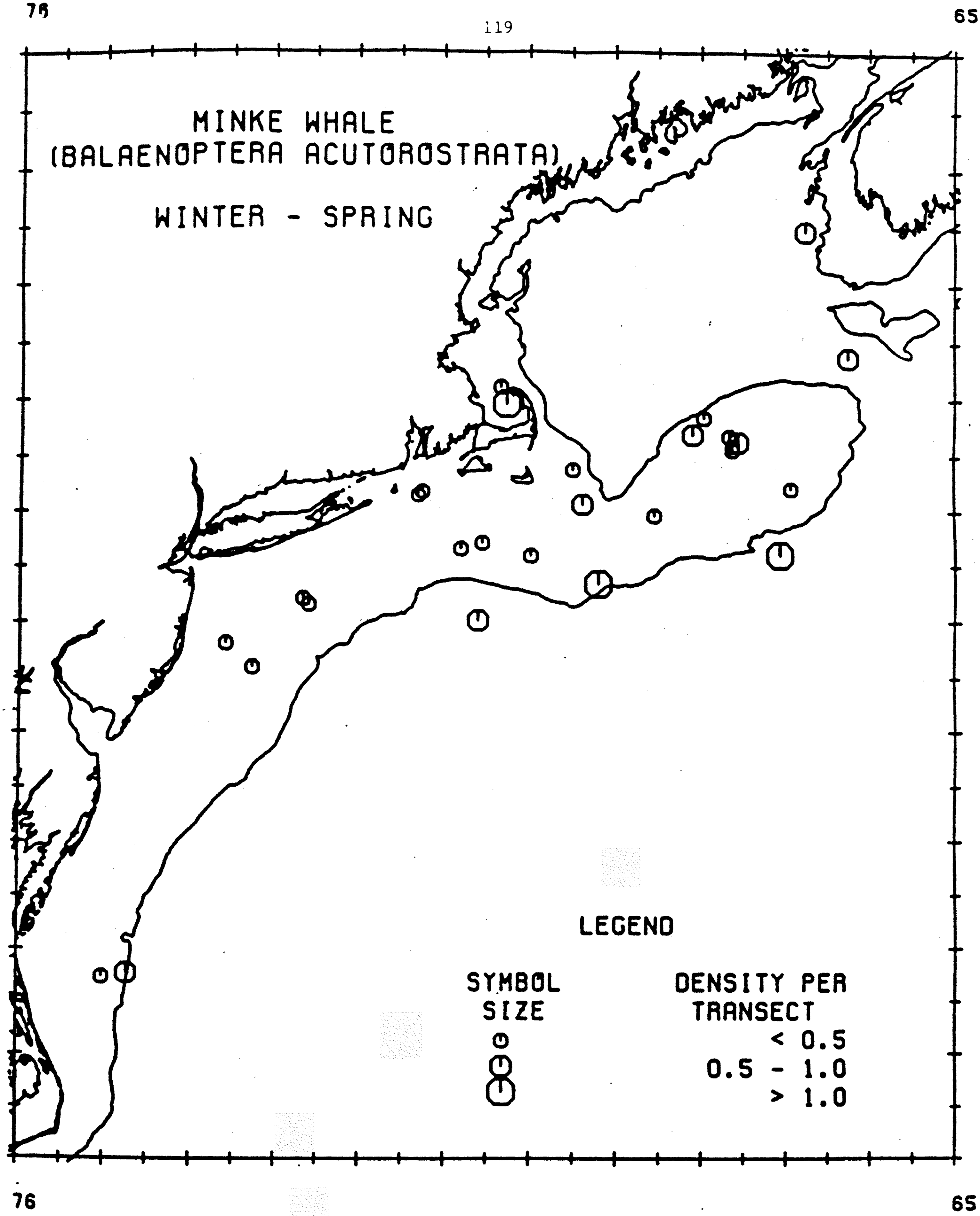
Figure 15b. Distribution of all minke whale sightings taken during shipboard surveys, for summer and fall 1980-1986, in shelf waters of the northeastern United States.

Figure 15c. Distribution of all minke whale sightings taken during shipboard surveys, for winter and spring 1980-1986, in shelf waters of the northeastern United States.

Figure 15d. Distribution of all minke whale sightings taken during shipboard surveys, by season, 1980-1986, in shelf waters of the northeastern United States.


76
65
MINKE WHALE
(BALAENOPTERA ACUTOROSTRATA)
ALL SEASONS
LEGEND
SYMBOL SIZE
DENSITY PER TRANSECT
< 0.5
0.5 - 1.0
> 1.0
76
65


76
65
MINKE WHALE
(BALAENOPTERA ACUTOROSTRATA)
SUMMER - FALL
LEGEND
SYMBOL SIZE
DENSITY PER TRANSECT
< 0.5
0.5 - 1.0
> 1.0
76
65


76
65
MINKE WHALE
(BALAENOPTERA ACUTOROSTRATA)
WINTER - SPRING
LEGEND
SYMBOL SIZE
DENSITY PER TRANSECT
< 0.5
0.5 - 1.0
> 1.0
76
65

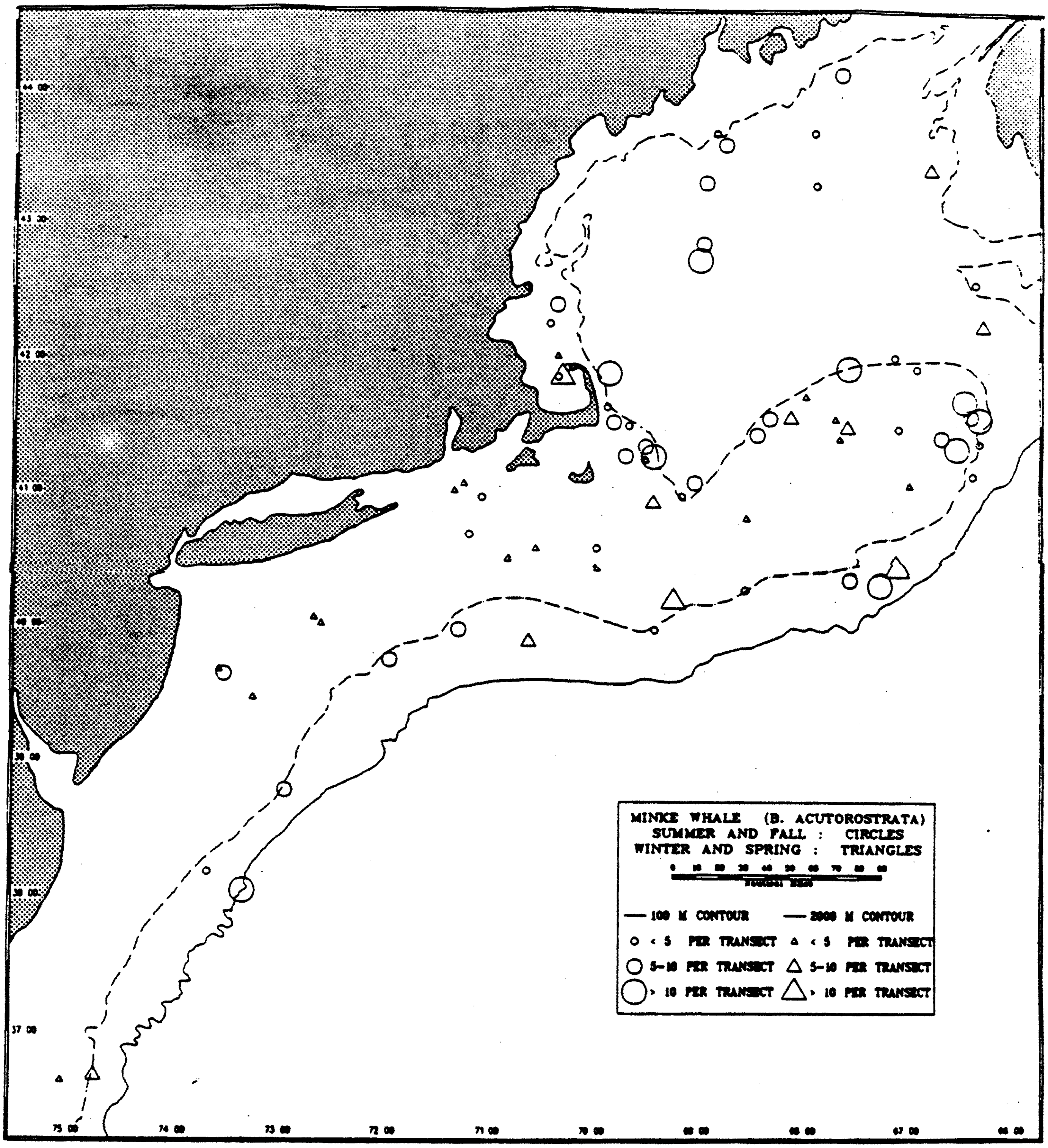

MINKE WHALE (B. ACUTOROSTRATA)
SUMMER AND FALL : CIRCLES
WINTER AND SPRING : TRIANGLES
100 M CONTOUR
2000 M CONTOUR
< 5 PER TRANSECT
< 5 PER TRANSECT
5-10 PER TRANSECT
5-10 PER TRANSECT
> 10 PER TRANSECT
> 10 PER TRANSECT

Table 31. Number of sightings, individuals and individuals/100 transects for minke whales, 1980 through 1987, all data combined.

REGION	SUB-REGION	SPRING SGHT-INGS	SPRING INDIV-IDUALS	SPRING IND'S PER - 100 TRANS	SUMMER SGHT-INGS	SUMMER INDIV-IDUALS	SUMMER IND'S PER - 100 TRANS	AUTUMN SGHT-INGS	AUTUMN INDIV-IDUALS	AUTUMN IND'S PER - 100 TRANS	WINTER SGHT-INGS	WINTER INDIV-IDUALS	WINTER IND'S PER - 100 TRANS	ANNUAL TOTAL SGHT-INGS	ANNUAL TOTAL INDIV-IDUALS	ANNUAL TOTAL IND'S PER - 100 TRANS
GULF OF MAINE	WEST	0	0	0	0	0	0	1	1	2	0	0	0	1	1	1
	CENTRAL	1	1	0	6	7	1	3	3	1	2	2	0	12	13	1
	SOUTHWEST	2	2	1	6	6	1	4	8	4	0	0	0	12	16	1
	SOUTH	0	0	0	1	2	1	1	1	1	0	0	0	2	3	0
	TOTAL	3	3	0	13	15	1	9	13	2	2	2	0	27	33	1
GEORGES BANK	N. EDGE	1	1	1	9	21	22	0	0	0	0	0	0	10	22	6
	SHOALS	6	6	2	3	4	1	1	1	0	0	0	0	10	11	1
	CENTRAL	1	1	0	17	34	5	2	2	0	0	0	0	20	37	1
	SHELF EDGE	1	2	2	1	3	2	1	2	1	0	0	0	3	7	1
	TOTAL	9	10	1	30	62	8	4	5	1	0	0	0	43	77	2
SOUTHERN NEW ENGLAND	INN. SHELF	1	1	0	4	4	1	0	0	0	0	0	0	5	5	0
	MID. SHELF	10	11	2	2	4	0	1	1	0	0	0	0	13	16	1
	OUT. SHELF	1	1	0	0	0	0	1	1	0	0	0	0	2	2	0
	TOTAL	12	13	1	6	8	0	2	2	0	0	0	0	20	23	0
MID-ATLANTIC BIGHT	INN. SHELF	0	0	0	0	0	0	0	0	0	1	1	0	1	1	0
	MID. SHELF	0	0	0	2	5	1	0	0	0	1	1	1	3	6	1
	OUT. SHELF	0	0	0	0	0	0	2	2	1	0	0	0	2	2	0
	CAROL.CAPE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	2	5	0	2	2	0	2	2	0	6	9	0
COASTAL ZONE	STRATUM 96	0	0	0	2	2	1	1	1	1	0	0	0	3	3	0
	STRATUM 95	0	0	0	0	0	0	0	0	0	1	2	2	1	2	0
	STRATUM 94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	2	2	0	1	1	0	1	2	1	4	5	0
CONTINENTAL SLOPE		0	0	0	1	10	2	0	0	0	0	0	0	1	10	1
ALL REGIONS COMBINED		24	26	1	54	102	2	18	23	1	5	6	0	101	157	1

13. FIN WHALE Balaenoptera physalus

The fin whale Balaenoptera physalus is the most widely distributed whale, both spatially and temporally, over the shelf waters of the northwest Atlantic.

In the shelf waters of the Gulf of Maine, including Georges Bank, there is an increase in fin whale sightings from spring through the fall, with a peak in summer (data from this report, Figures 16a-d, Table 32). The areas of Jeffreys Ledge, Stellwagen Bank and the Great South Channel have the greatest concentrations of whales during these seasons (Figures 16a-16d). There is a decrease in on-shelf sightings of fin whales in winter (Figure 15b). However, fin whales do overwinter in the Gulf of Maine and on Georges Bank. This is especially apparent on Stellwagen Bank and within the Great South Channel.

Monitoring from shipboard surveys

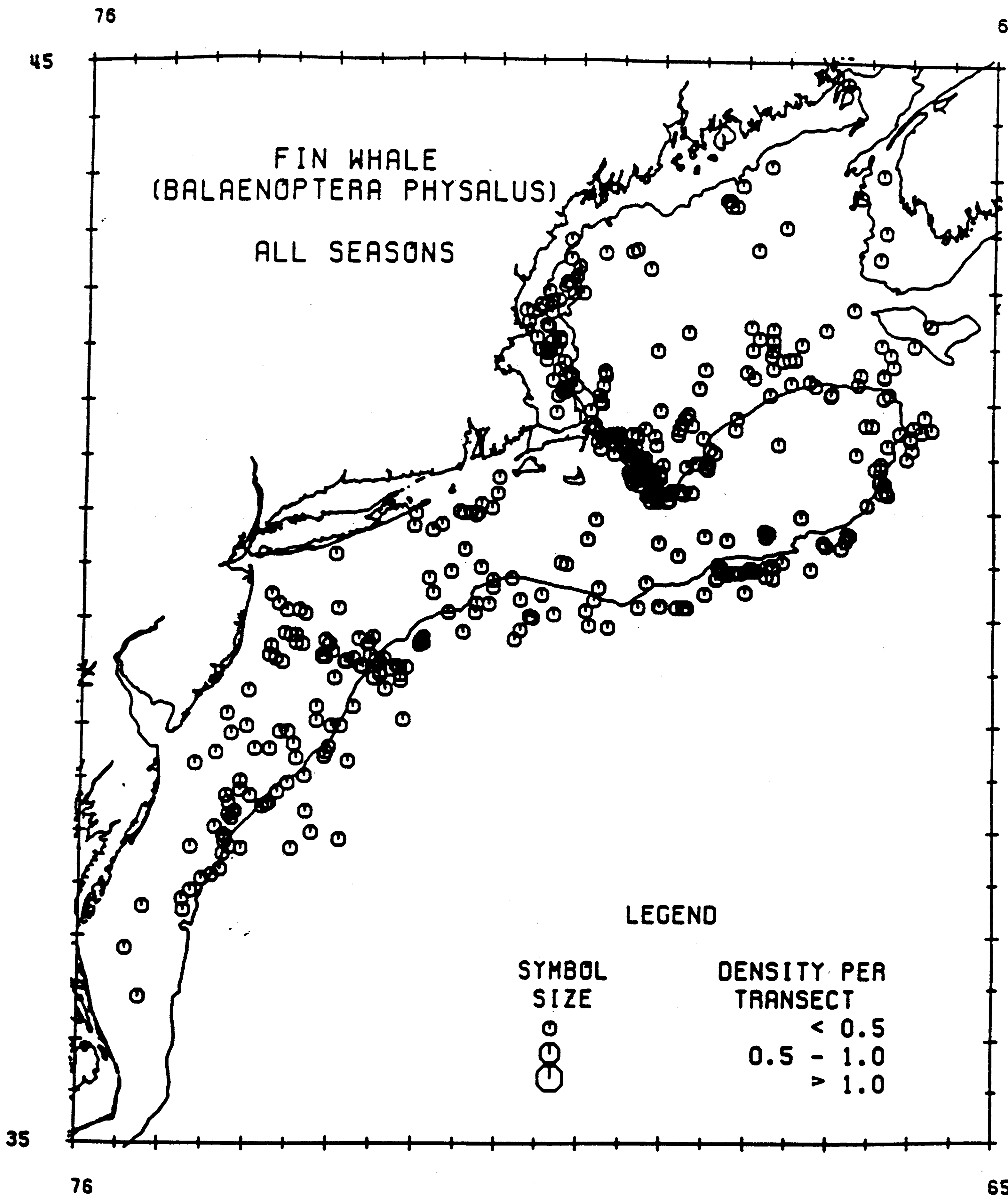
Although fin whales can be found in all regions during all seasons they are most abundant in the south and southwest Gulf of Maine, and along the perimeter of Georges Bank during summer and fall. Monitoring could be best accomplished during that period in those regions.

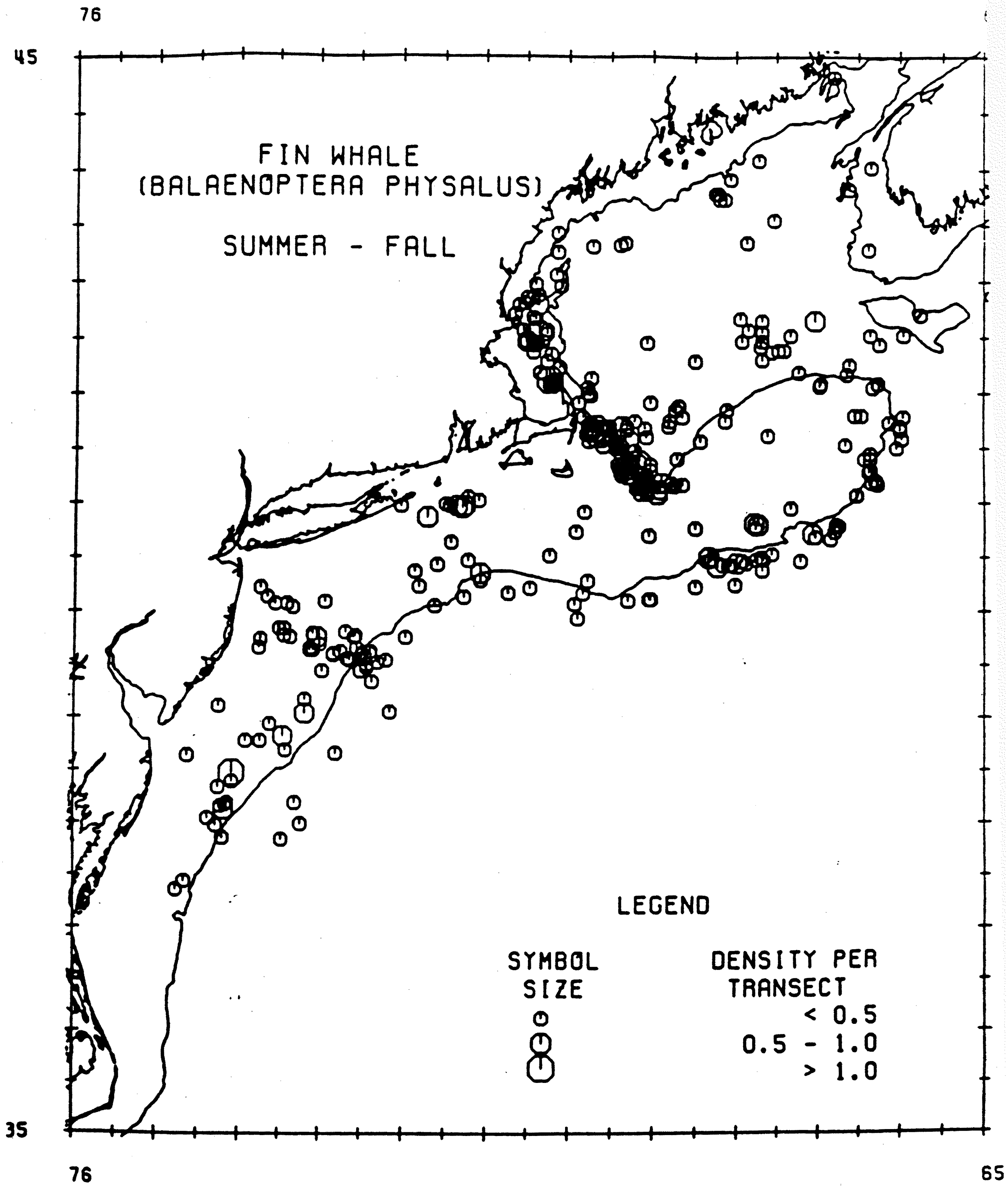
Figure 16a. Distribution of all fin whale sightings taken during shipboard surveys, for all seasons 1980-1986, in shelf waters of the northeastern United States.

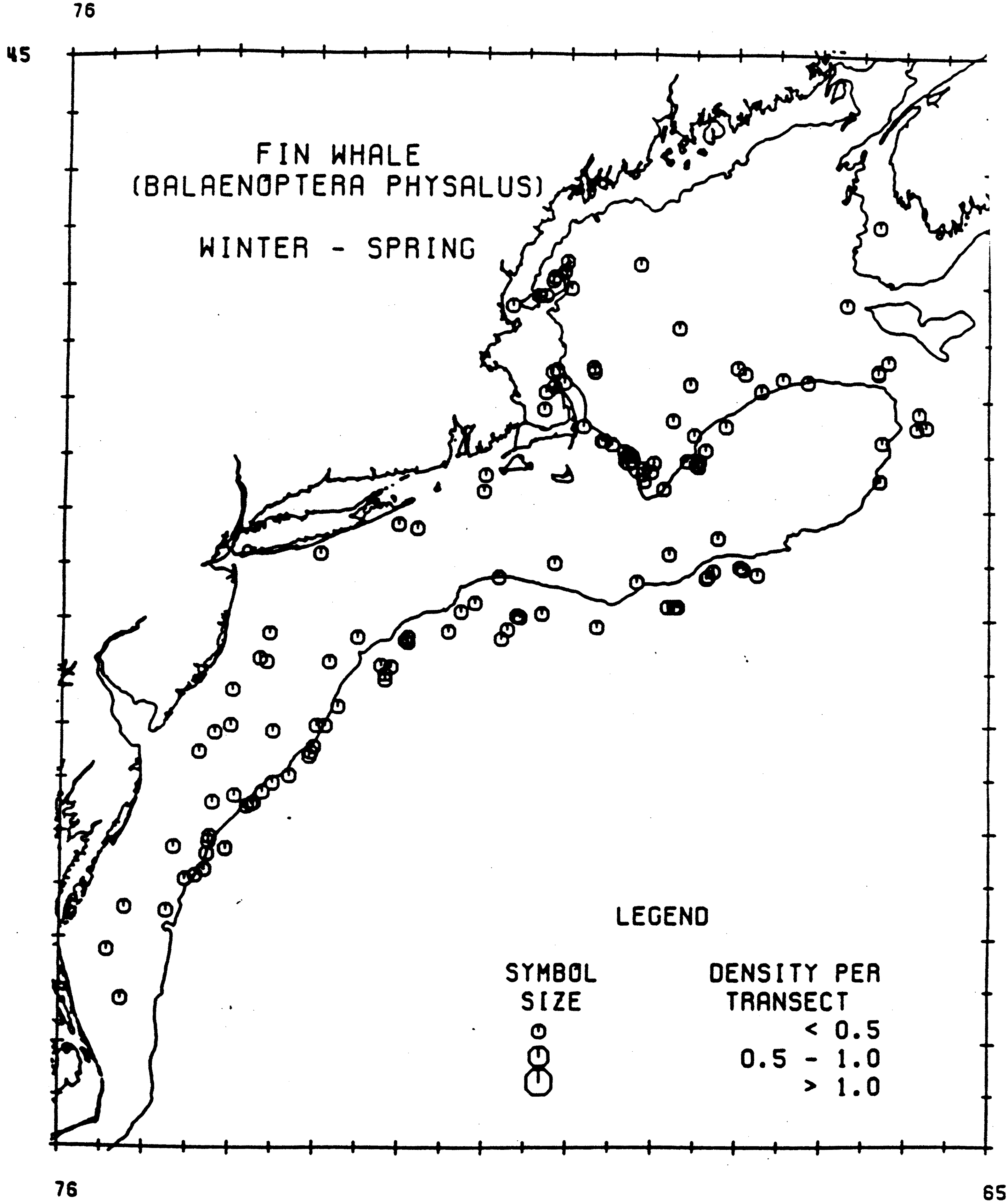
Figure 16b. Distribution of all fin whale sightings taken during shipboard surveys, for summer and fall 1980-1986, in shelf waters of the northeastern United States.

Figure 16c. Distribution of all fin whale sightings taken during shipboard surveys, for winter and spring 1980-1986, in shelf waters of the northeastern United States.

Figure 16d. Distribution of all fin whale sightings taken during shipboard surveys, by season, 1980-1986, in shelf waters of the northeastern United States.


76
65
45
35
76
65
FIN WHALE
(BALAENOPTERA PHYSALUS)
ALL SEASONS
LEGEND
SYMBOL
SIZE
DENSITY PER
TRANSECT
< 0.5
0.5 - 1.0
> 1.0


76
45
FIN WHALE
(BALAENOPTERA PHYSALUS)
SUMMER - FALL
LEGEND
SYMBOL SIZE
DENSITY PER TRANSECT
< 0.5
0.5 - 1.0
> 1.0
35
76
65


76
45
FIN WHALE
(BALAENOPTERA PHYSALUS)
WINTER - SPRING
LEGEND
SYMBOL SIZE
DENSITY PER TRANSECT
< 0.5
0.5 - 1.0
> 1.0
76
65

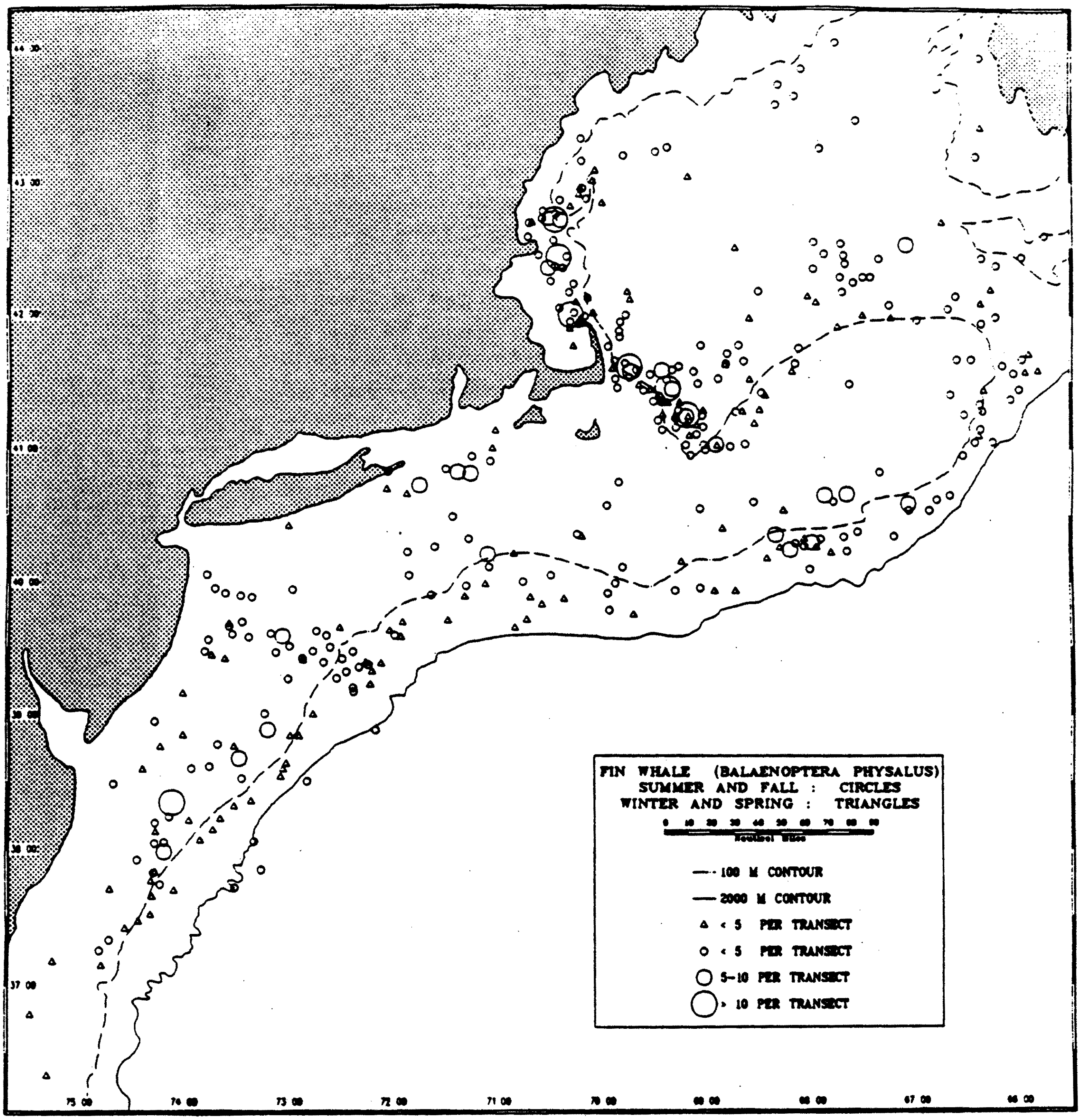

FIN WHALE (BALAENOPTERA PHYSALUS)
SUMMER AND FALL : CIRCLES
WINTER AND SPRING : TRIANGLES
100 M CONTOUR
2000 M CONTOUR
< 5 PER TRANSECT
< 5 PER TRANSECT
5-10 PER TRANSECT
> 10 PER TRANSECT

Table 32. Number of sightings, individuals and individuals/100 transects for fin whales, 1980 through 1987, all data combined.

REGION	SUB-REGION	SPRING SGHT-INGS	SPRING INDIV-IDUALS	SPRING IND'S PER - 100 TRANS	SUMMER SGHT-INGS	SUMMER INDIV-IDUALS	SUMMER IND'S PER - 100 TRANS	AUTUMN SGHT-INGS	AUTUMN INDIV-IDUALS	AUTUMN IND'S PER - 100 TRANS	WINTER SGHT-INGS	WINTER INDIV-IDUALS	WINTER IND'S PER - 100 TRANS	ANNUAL TOTAL SGHT-INGS	ANNUAL TOTAL INDIV-IDUALS	ANNUAL TOTAL IND'S PER - 100 TRANS
GULF OF MAINE	WEST	0	0	0	2	4	12	2	3	7	0	0	0	4	7	5
	CENTRAL	2	2	1	10	16	3	23	29	6	4	4	1	39	51	3
	SOUTHWEST	13	27	14	84	219	39	15	33	15	7	12	7	119	291	18
	SOUTH	8	11	8	24	43	25	8	8	4	2	2	2	42	64	10
	TOTAL	23	40	6	120	282	20	48	73	8	13	18	2	204	413	9
GEORGES BANK	N. EDGE	3	8	10	3	13	14	4	5	4	1	1	3	11	27	8
	SHOALS	1	2	1	2	3	1	3	7	3	0	0	0	6	12	1
	CENTRAL	2	6	2	19	46	7	15	29	7	3	3	1	39	84	4
	SHELF EDGE	6	7	5	1	1	1	21	39	23	1	1	2	29	48	8
	TOTAL	12	23	5	25	63	6	43	80	10	5	5	2	85	171	5
SOUTHERN NEW ENGLAND	INN. SHELF	3	4	1	17	39	5	2	2	0	2	2	1	24	47	2
	MID. SHELF	13	18	3	22	83	10	5	6	1	0	0	0	40	107	4
	OUT. SHELF	15	21	7	8	18	10	8	8	3	0	0	0	31	47	5
	TOTAL	31	43	4	47	140	8	15	16	1	2	2	0	95	201	3
MID-ATLANTIC BIGHT	INN. SHELF	10	12	2	12	29	3	0	0	0	1	2	1	23	43	2
	MID. SHELF	7	9	3	7	20	4	3	10	3	1	1	1	18	40	3
	OUT. SHELF	6	8	4	1	4	2	0	0	0	1	1	2	8	13	2
	CAROL.CAPE	0	0	0	1	4	17	0	0	0	0	0	0	1	4	4
	TOTAL	23	29	2	21	57	7	3	10	1	3	4	1	50	100	3
COASTAL ZONE	STRATUM 96	1	1	1	9	10	5	0	0	0	1	1	1	11	12	2
	STRATUM 95	1	1	0	2	3	1	0	0	0	0	0	0	3	4	0
	STRATUM 94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	2	2	0	11	13	2	0	0	0	1	1	0	14	16	1
CONTINENTAL SLOPE		2	3	1	5	9	2	2	4	1	0	0	0	9	16	1
ALL REGIONS COMBINED		93	140	3	229	564	8	111	183	4	24	30	1	457	917	4

14. BLUE WHALE Balaenoptera musculus

Within the Gulf of Maine, the first documented sighting of a blue whale occurred on 4 October 1986, north of Race Point, Cape Cod (42 07'N, 70 22.5'W (Wenzel et al. 1988). This whale was also reported the following day approximately 10km north of the original position. The following spring, on 18 May 1987 three blue whales were observed from NMFS research vessels on northwest Georges Bank at 41o18'n, 68o42'W. All three of these whales showed the characteristic mottled back and small dorsal fin, and then lifted their flukes on a deep dive. Another large whale "with a tremendous blow" surfaced several km from the vessel. On 29 July 1987 another blue whale was observed on southwest Georges Bank at 40o38'N, 68o04'W. This whale was observed in the company of several right whales Eubalaena glacialis and basking sharks Cetorhinus maximus. On 9 August 1987 a blue whale was reported southeast of Cape Ann, Massachusetts and then resighted on 11 August north of Race Point, Massachusetts (42 14'n, 70 20'W). On 30 August 1987, a third blue whale was observed east of Nauset Beach, Cape Cod (41 48'N, 69 45'W). The 1986 sighting and the two sightings in August 1987 were from commercial whalewatching vessels. It could be determined from the mottled pattern on the animals that these were three different whales, and that the whale identified on 9 and 11 August had been previously observed in the Gulf of St. Lawrence (from data in Sears and Wenzel 1987). The sightings in May and July 1987 occurred on larger research vessels from a greater distance, and individual identification could not be determined. Based on the individual identifications, and the dates and locations of verified sightings, the number of blue whales in Massachusetts waters during summer 1987 was likely between 3 and 8 individuals.

Prior to these sightings, the closest sightings (to our study area) were observed and confirmed on the shelf edge seventy miles SE of Cape Sable, Nova Scotia on 19 August 1980 (CeTAP 1982). Prior to 1986 these were the only verified sightings reported from the shelf or near shelf waters of the northeastern United States. There are no verified records south of Cape Hatteras, North Carolina.

The increase in the number of blue whale sightings during 1986-1987 reflected a dramatic change in the distribution for this species, likely resulting from an abrupt change in prey availability in Massachusetts waters. Sighting data for other species which feed in a similar manner and on the same types of prey also showed similar changes in 1986 and 1987 (see Kenney, in press).

<u>Monitoring from shipboard surveys</u>

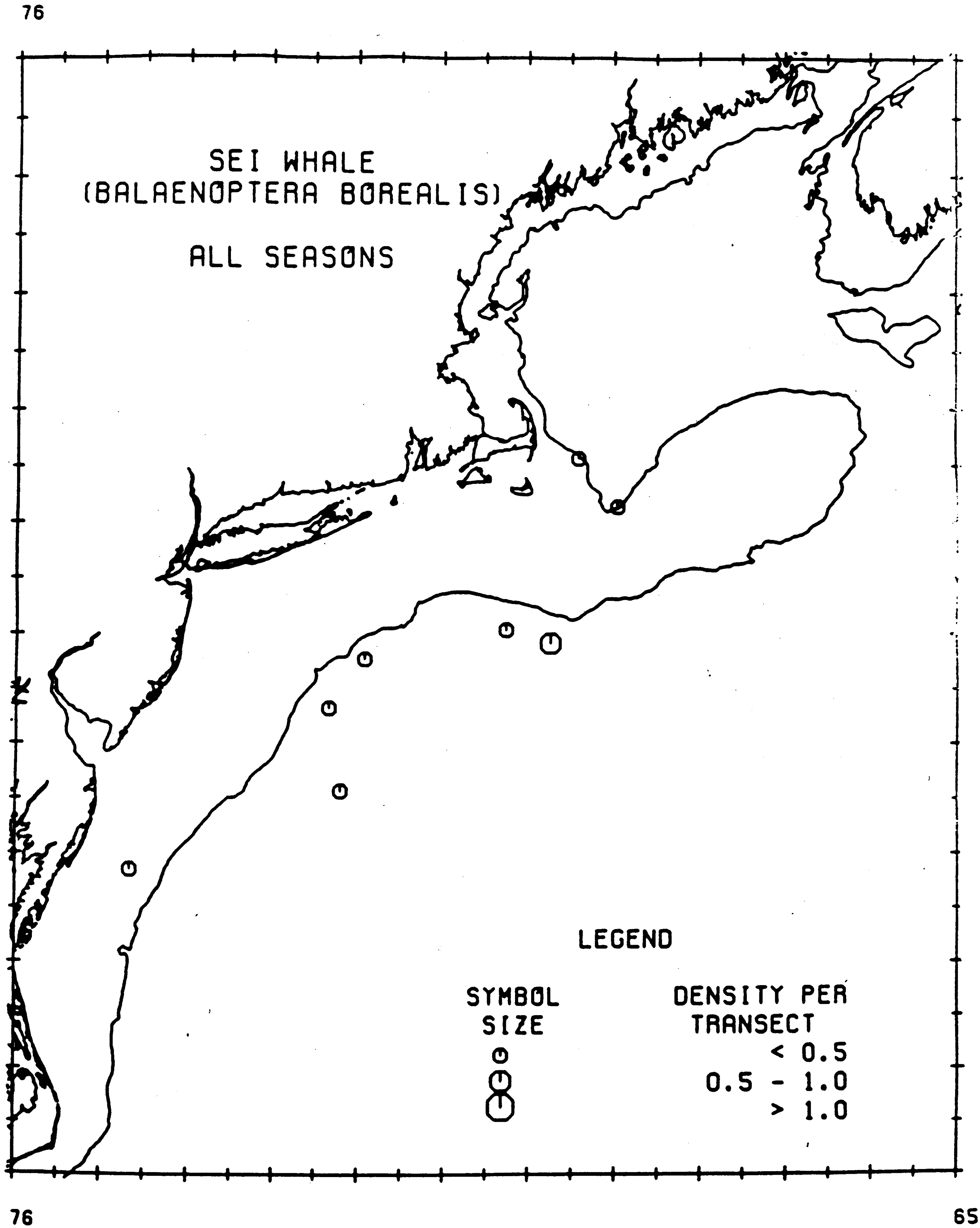
This species generally is absent from shelf waters of the northeastern United States and except for the 1986-1987 sightings, all sightings have been from slope waters. The monitoring of this species would be considered opportunistic.

15. SEI WHALE _Balaenoptera_ _borealis_

Evidence suggests that two stocks of sei whales occur in the northwest Atlantic (Mitchell and Chapman 1974), one with its center of abundance off eastern Nova Scotia and another centered in the Labrador Sea. Sightings in the shelf waters off the northeastern United States occur along the outside of Georges Bank (Figures 17a, 17b), all in the summer (17b). New England water are considered the southern end of the feeding range of this species (Kenney, in press). In early June, sei whales begin to move along the continental slope off the eastern United States, arriving on Georges and Browns Bank and in the northeast Channel by mid-to late June (Mitchell and Kozicki 1974). The whales on the Scotian Shelf apparently migrate northward along the continental slope in June and July, and then return southward from mid-September to mid-November (Mitchell and Chapman 1974). During 1986 sei whales moved into the Great South Channel and onto Stellwagen Bank in summer. This accounts for the numbers present in the southwest Gulf of Maine (in Table 33). Except for this one year, sei whales have been absent from Gulf of Maine waters since the early 1970's. This may be due to competition by sandlance _Ammodytes_ _spp._ for copepods, the preferred prey of both species.

Figure 17a. Distribution of all sei whale sightings taken during shipboard surveys, for all seasons 1980-1986, in shelf waters of the northeastern United States.

Figure 17b. Distribution of all sei whale sightings taken during shipboard surveys, by season, 1980-1986, in shelf waters of the northeastern United States.


76
SEI WHALE
(BALAENOPTERA BOREALIS)
ALL SEASONS
LEGEND
SYMBOL SIZE
DENSITY PER TRANSECT
< 0.5
0.5 - 1.0
> 1.0
76
65

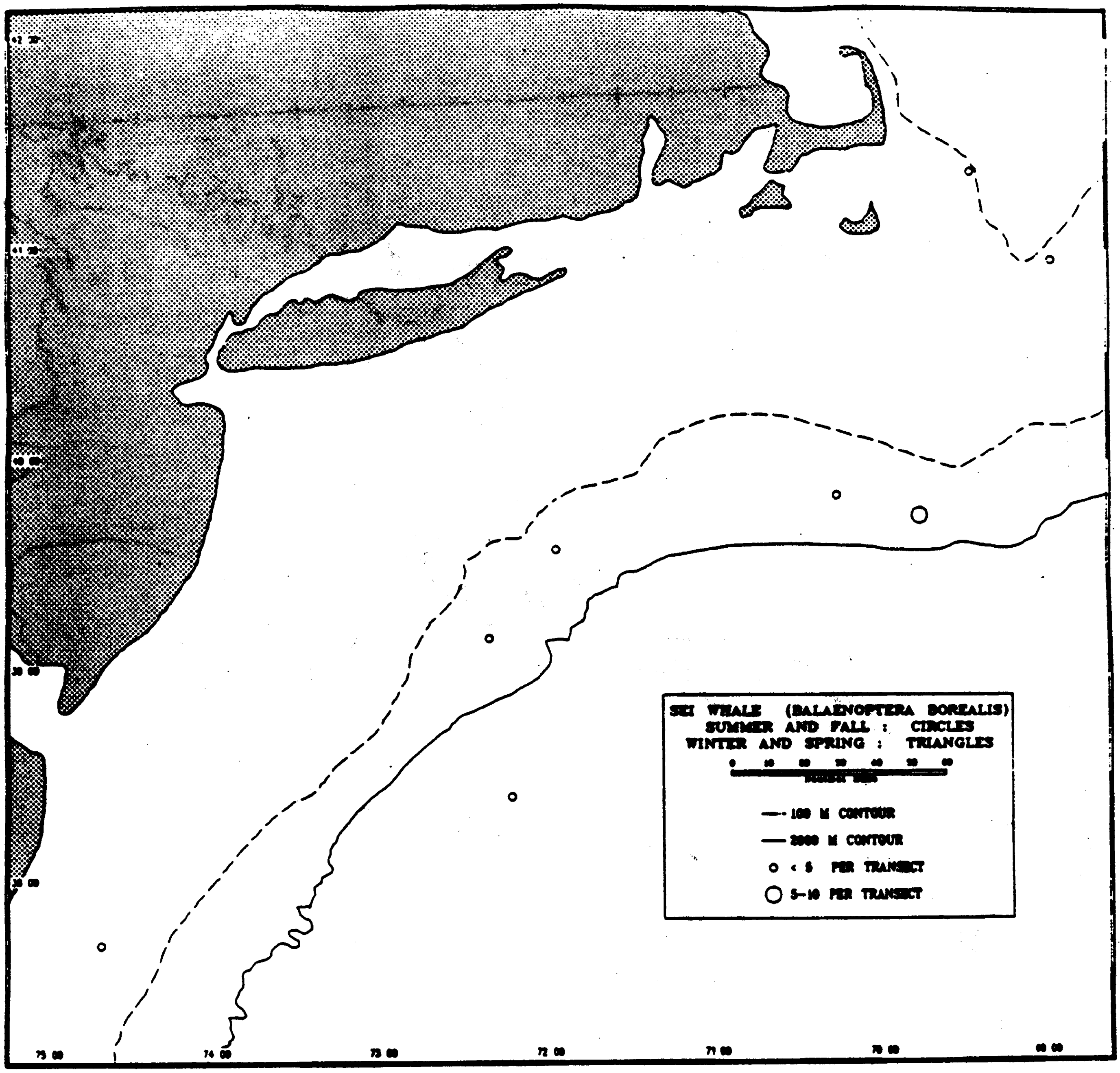

SEI WHALE (BALAENOPTERA BOREALIS)
SUMMER AND FALL : CIRCLES
WINTER AND SPRING : TRIANGLES
100 M CONTOUR
2000 M CONTOUR
< 5 PER TRANSECT
5-10 PER TRANSECT
75 00
74 00
73 00
72 00
71 00
70 00

Table 33. Number of sightings, individuals and individuals/100 transects for sei whales, 1980 through 1987, all data combined.

REGION	SUB-REGION	SPRING SGHT-INGS	SPRING INDIV-IDUALS	SPRING IND'S PER - 100 TRANS	SUMMER SGHT-INGS	SUMMER INDIV-IDUALS	SUMMER IND'S PER - 100 TRANS	AUTUMN SGHT-INGS	AUTUMN INDIV-IDUALS	AUTUMN IND'S PER - 100 TRANS	WINTER SGHT-INGS	WINTER INDIV-IDUALS	WINTER IND'S PER - 100 TRANS	ANNUAL TOTAL SGHT-INGS	ANNUAL TOTAL INDIV-IDUALS	ANNUAL TOTAL IND'S PER - 100 TRANS
GULF OF MAINE	WEST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CENTRAL	0	0	0	1	1	0	0	0	0	0	0	0	1	1	0
	SOUTHWEST	0	0	0	3	4	1	0	0	0	0	0	0	3	4	0
	SOUTH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	4	5	0	0	0	0	0	0	0	4	5	0
GEORGES BANK	N. EDGE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SHOALS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CENTRAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SHELF EDGE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SOUTHERN NEW ENGLAND	INN. SHELF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	MID. SHELF	1	1	0	0	0	0	1	1	0	0	0	0	2	2	0
	OUT. SHELF	2	4	1	0	0	0	0	0	0	0	0	0	2	4	0
	TOTAL	3	5	1	0	0	0	1	1	0	0	0	0	4	6	0
MID-ATLANTIC BIGHT	INN. SHELF	1	1	0	0	0	0	0	0	0	0	0	0	1	1	0
	MID. SHELF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	OUT. SHELF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CAROL.CAPE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	1	1	0	0	0	0	0	0	0	0	0	0	1	1	0
COASTAL ZONE	STRATUM 94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	STRATUM 95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	STRATUM 94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CONTINENTAL SLOPE		1	1	0	0	0	0	0	0	0	0	0	0	1	1	0
ALL REGIONS COMBINED		5	7	0	4	5	0	1	1	0	0	0	0	10	13	0

HUMPBACK WHALE _Megaptera_ _novaeangliae_

Several individual stocks of humpbacks have been suggested in the northwest Atlantic (Katona et al. 1982). In the northwest Atlantic, the major summer concentrations of humpbacks occur off the coasts of Newfoundland and Labrador, and off the coasts of New England in the Gulf of Maine (Katona et al. 1980; Whitehead et al. 1982). During this period, feeding is their principal activity. The major winter concentrations in the western North Atlantic occur along the Antillean chain in the West Indies, principally on Silver and Navidad Banks which lie north of the Dominican Republic (Winn et al. 1975; Balcomb and Nichols 1978; Whitehead and Moore 1982). The migratory route between regions of winter breeding and summer feeding in the northwest Atlantic (based on sighting data occurs in deeper, slope waters off the continental shelf. There are at least two possible offshore routes betwen these winter and summer areas: 1) Dominican Republic to the Gulf of Maine and 2) Puerto Rico to Newfoundland suggesting distinct stocks (Katona et al. 1980). For the Gulf of Maine stock, the Great South Channel has been suggested (Kenney et al. 1981; Payne et al. 1986) as the major exit/entry between the Gulf of Maine feeding area and the deeper, offshore migration route.

In the Gulf of Maine, humpback whales generally are located in the waters from the southern limit of the Great South Channel north to, and including, all of the Gulf of Maine (north of 40o00N latitude)between mid-March and November (data from this report, Figures 18a-d, Table 34). Cetap (1982) reported only 10 winter sightings between 1978 and 1981. Payne et al. (1984) confirmed these low figures from shipboard surveys. Within this spatial and temporal framework, concentrations are greatest in a narrow band between 41o00 and 43o00N latitudes, from the Great South Channel north along the outside of Cape Cod to Stellwagen Bank and Jeffreys Ledge, in the south and southwest regions of the Gulf of Maine. Humpback whales also are reported in the lower Bay of Fundy Neave and Wright 1968; Kraus and Prescott 1981. The lack of sightings in the mid-Atlantic bight supports the offshore movement patterns of the humpback whales south of 40o00 latitude.

<u>Monitoring from shipboard surveys</u>

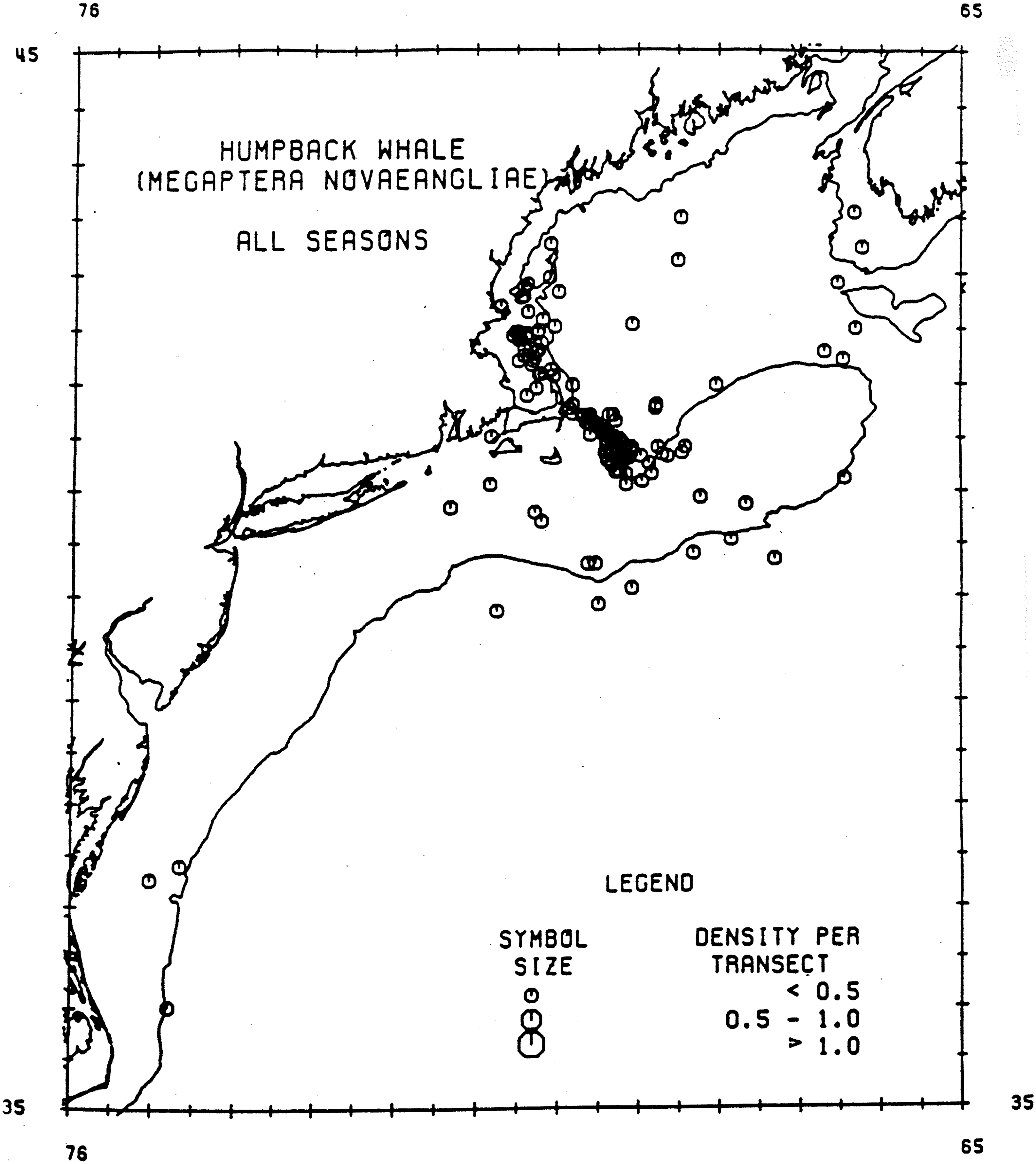
Humpback whales are present spring through summer in large numbers in the south and southwest regions of the Gulf of Maine. Monitoring of this species from shipboard surveys can be accomplished at these times.

Figure 18a. Distribution of all humpback whale sightings taken during shipboard surveys, for all seasons 1980-1986, in shelf waters of the northeastern United States.

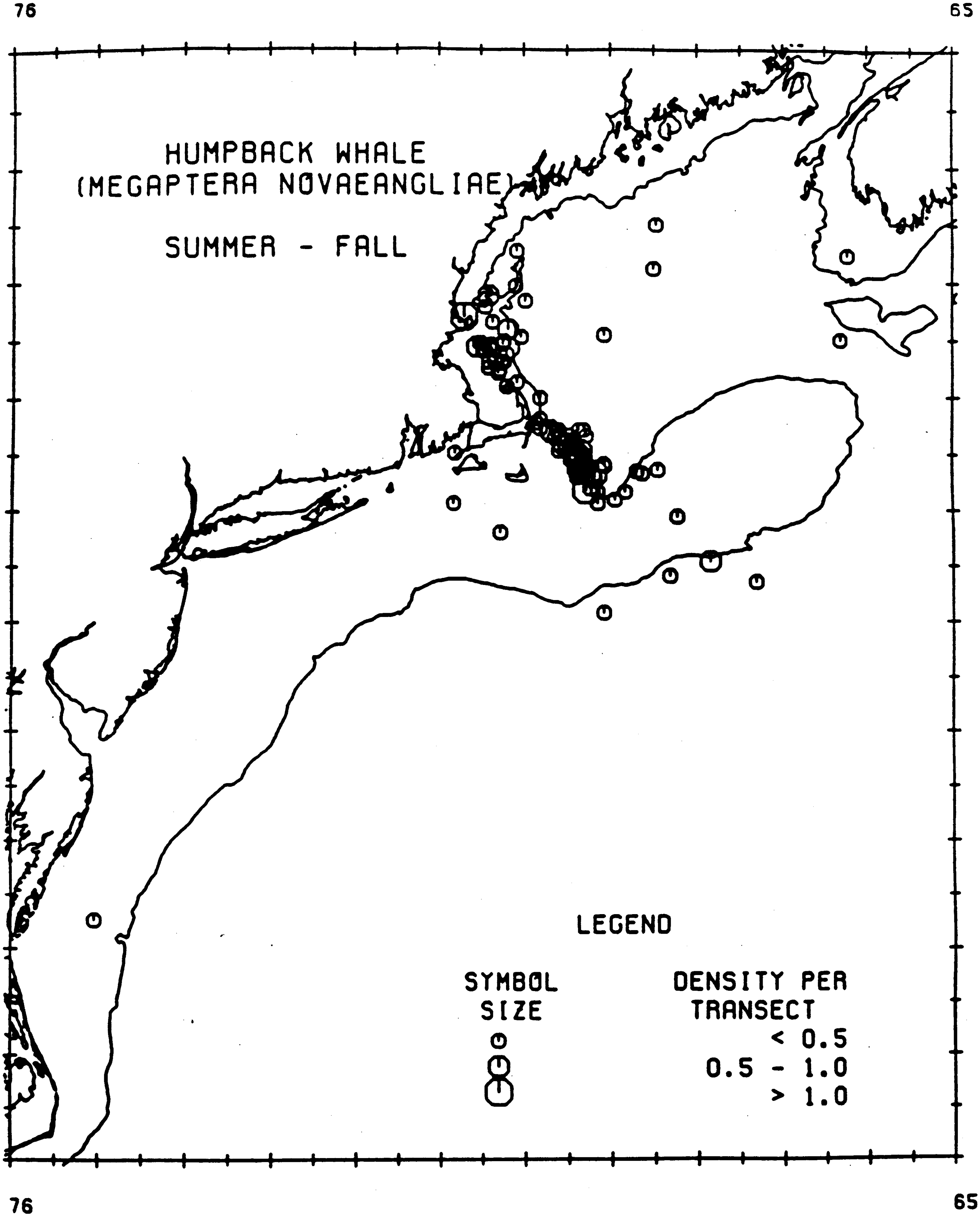
Figure 18b. Distribution of all humpback whale sightings taken during shipboard surveys, for summer and fall 1980-1986, in shelf waters of the northeastern United States.

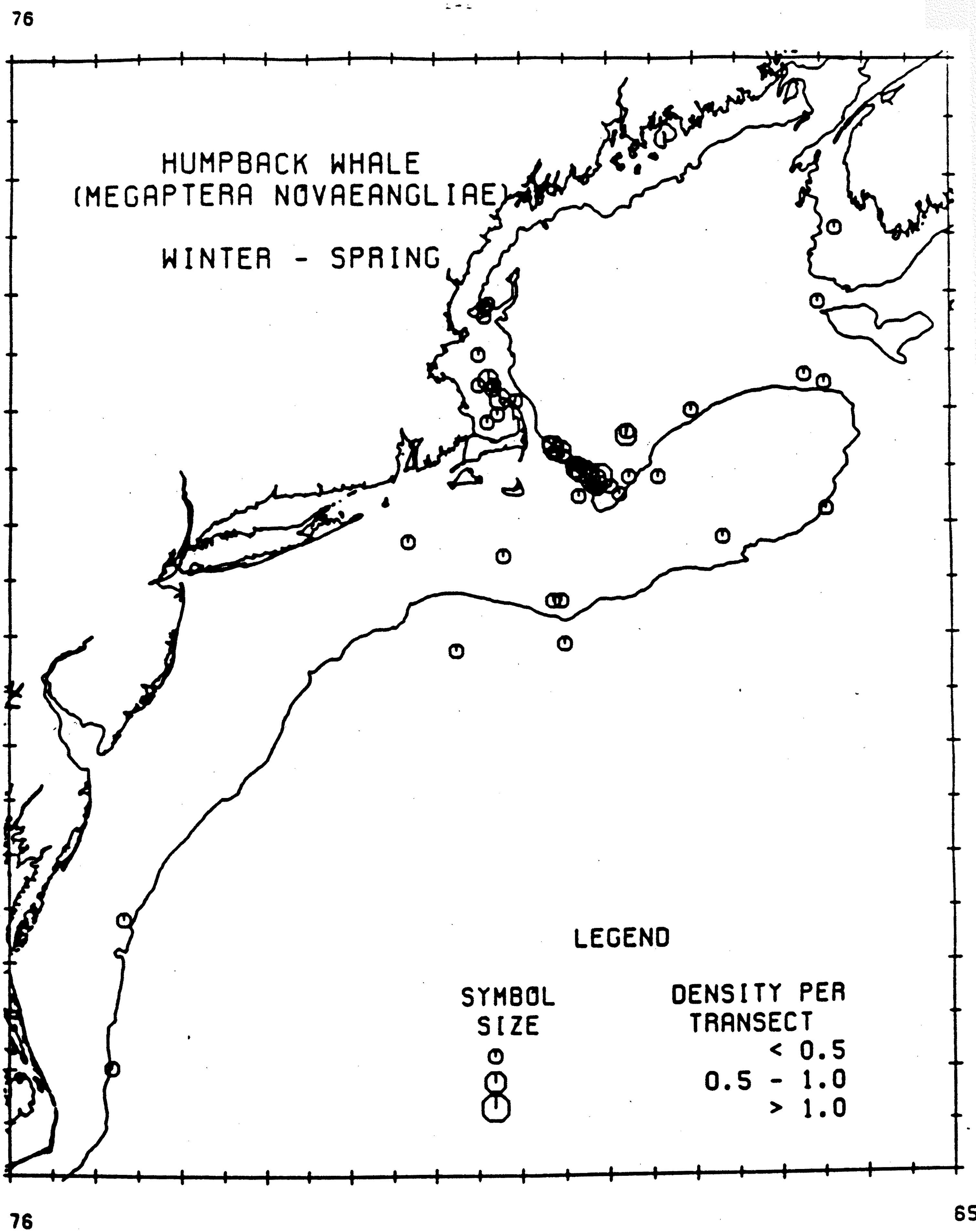
Figure 18c. Distribution of all humpback whale sightings taken during shipboard surveys, for winter and spring 1980-1986, in shelf waters of the northeastern United States.

Figure 18d. Distribution of all humpback whale sightings taken during shipboard surveys, by season, 1980-1986, in shelf waters of the northeastern United States.



76
65
45
HUMPBACK WHALE
(MEGAPTERA NOVAEANGLIAE)
ALL SEASONS
LEGEND
SYMBOL SIZE
DENSITY PER TRANSECT
< 0.5
0.5 - 1.0
> 1.0
35
35
76
65


76
65
HUMPBACK WHALE
(MEGAPTERA NOVAEANGLIAE)
SUMMER - FALL
LEGEND
SYMBOL SIZE
DENSITY PER TRANSECT
< 0.5
0.5 - 1.0
> 1.0
76
65


76
HUMPBACK WHALE
(MEGAPTERA NOVAEANGLIAE)
WINTER - SPRING
LEGEND
SYMBOL SIZE
DENSITY PER TRANSECT
< 0.5
0.5 - 1.0
> 1.0
76
65

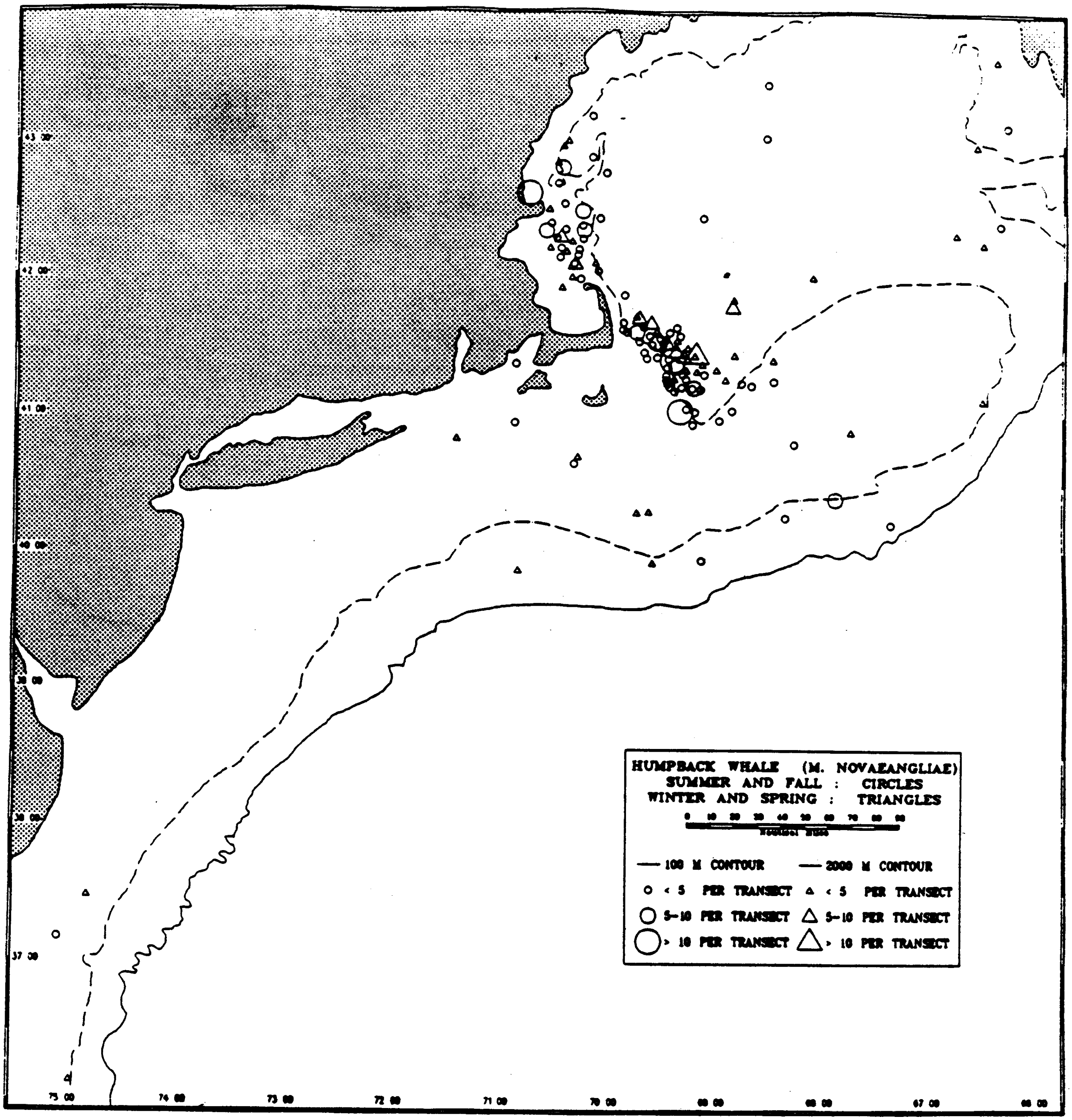

HUMPBACK WHALE (M. NOVAEANGLIAE)
SUMMER AND FALL : CIRCLES
WINTER AND SPRING : TRIANGLES
0 10 20 30 40 50 60 70 80 90
100 M CONTOUR
2000 M CONTOUR
< 5 PER TRANSECT
< 5 PER TRANSECT
5-10 PER TRANSECT
5-10 PER TRANSECT
> 10 PER TRANSECT
> 10 PER TRANSECT
75 00
74 00
73 00
72 00
71 00
70 00
69 00
68 00
67 00
66 00

Table 34. Number of sightings, individuals and individuals/100 transects for humpback whales, 1980 through 1987, all data combined.

REGION	SUB-REGION	SPRING SGHT-INGS	SPRING INDIV-IDUALS	SPRING IND'S PER - 100 TRANS	SUMMER SGHT-INGS	SUMMER INDIV-IDUALS	SUMMER IND'S PER - 100 TRANS	AUTUMN SGHT-INGS	AUTUMN INDIV-IDUALS	AUTUMN IND'S PER - 100 TRANS	WINTER SGHT-INGS	WINTER INDIV-IDUALS	WINTER IND'S PER - 100 TRANS	ANNUAL TOTAL SGHT-INGS	ANNUAL TOTAL INDIV-IDUALS	ANNUAL TOTAL IND'S PER - 100 TRANS
GULF OF MAINE	WEST	0	0	0	1	4	12	0	0	0	0	0	0	1	4	3
	CENTRAL	1	2	1	1	1	0	5	6	1	0	0	0	7	9	1
	SOUTHWEST	11	31	14	77	204	36	13	55	25	0	0	0	105	298	20
	SOUTH	8	30	22	14	34	20	2	4	2	4	8	4	24	68	11
	TOTAL	20	63	10	93	243	17	20	65	7	4	8	1	137	379	9
GEORGES BANK	N. EDGE	1	1	1	2	6	4	0	0	0	0	0	0	3	7	2
	SHOALS	0	0	0	0	0	0	1	1	0	0	0	0	1	1	0
	CENTRAL	1	1	0	1	1	0	0	0	0	1	1	0	3	3	0
	SHELF EDGE	0	0	0	1	5	4	2	3	2	0	0	0	3	8	1
	TOTAL	2	2	0	4	12	2	3	4	1	1	1	0	10	19	1
SOUTHERN NEW ENGLAND	INN. SHELF	0	0	0	1	1	0	1	2	0	0	0	0	2	3	0
	MID. SHELF	2	3	1	0	0	0	2	2	0	1	1	0	5	6	0
	OUT. SHELF	2	2	1	0	0	0	0	0	0	0	0	0	2	2	0
	TOTAL	4	5	0	1	1	0	3	4	0	1	1	0	9	11	0
MID-ATLANTIC BIGHT	INN. SHELF	0	0	0	0	0	0	1	1	0	0	0	0	1	1	0
	MID. SHELF	1	2	1	1	1	0	0	0	0	0	0	0	2	3	0
	OUT. SHELF	2	2	1	0	0	0	0	0	0	0	0	0	2	3	0
	CAROL.CAPE	0	0	0	0	0	0	0	0	0	1	1	2	3	3	1
	TOTAL	3	4	0	1	1	0	1	1	0	1	1	0	6	7	0
COASTAL ZONE	STRATUM 96	1	1	1	4	9	4	0	0	0	3	8	5	8	18	3
	STRATUM 95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	STRATUM 94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	1	1	0	4	9	1	0	0	0	3	8	2	8	18	1
CONTINENTAL SLOPE		0	0	0	1	1	0	0	0	0	0	0	0	1	1	0
ALL REGIONS COMBINED		30	75	2	104	267	4	27	74	2	10	19	1	171	435	2

16. RIGHT WHALE <u>Eubalaena glacialis</u>

Aggregations of right whales may still be observed in several locations within and adjacent to our study area. At least part of the population overwinters along the coast from North Carolina to Florida (Kraus in press; Winn et al. 1984) and in Cape Cod Bay. During the spring, the Great South Channel and Cape Cod Bay are consistently inhabited by this species. From June through October the right whale distribution appears to be centered on the southern Scotian shelf in the vicinity of Browns and Bacarro Banks, and in the Bay of Fundy (Cetap 1982; Kraus 1982; Kraus 1983; Kraus, in press).

In Cape Cod Bay right whales have been observed skim feeding, socializing and courting since the early 1950s (Watkins and Schevill 1976; Mayo et al. 1985). The coastal coves from South Carolina to Florida have been well documented as a principle calving area (Reeves et al. 1978). Mayo et al. (1985) also suggests that the eastern side of Cape Cod Bay north to Stellwagen Basin and the eastern side of Stellwagen Bank important are also areas for socializing asnd feeding.

Between December and March small numbers of right whales may occur in waters of the Gulf of Maine and western Georges Bank. Another wintering ground for this species occurs on the Georgia -Florida Bight where relatively newborn calves have been located (Kraus et al. 1984; Kraus 1986) . Approximately 10-20 right whales are sighted annually at this location. This wintering group has been tied with those whales that move into the Gulf of Maine-lower Bay of Fundy during the spring and summer. In the spring, right whale concentrations in the Gulf of Maine occur principally in three locations, the Great South Channel, Cape Cod Bay north to Jeffreys Ledge, and the northern Gulf of Maine-lower Bay of Fundy (from Kraus et al. 1984). A few right whales remain in Massachusetts waters through the summer, however most of the population spends the summer and fall in the Bay of Fundy and on the

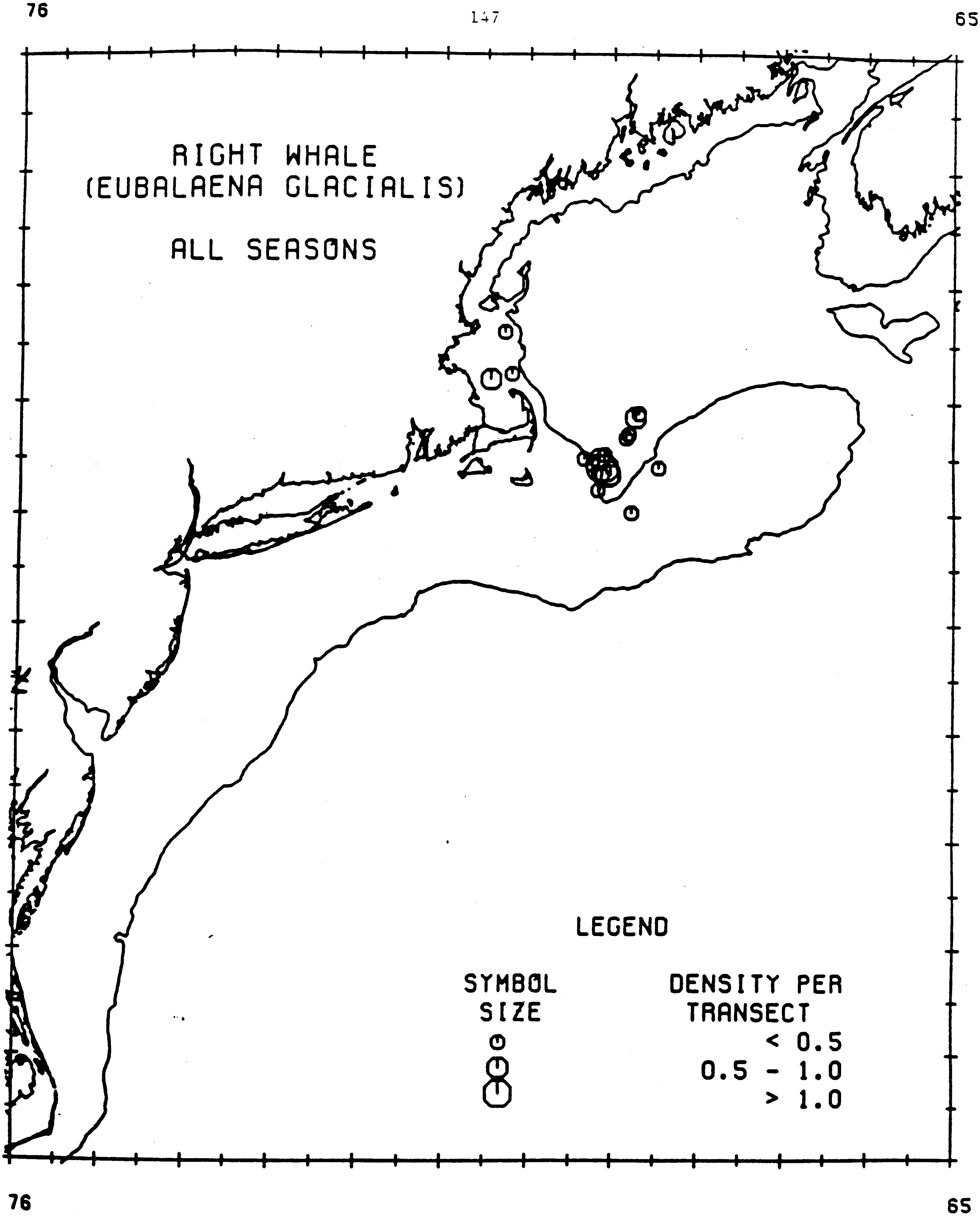
Scotian Shelf (Kraus et al. 1984; Kraus 1986). Movements of right whales within the Gulf of Maine have been fairly well documented. The largest single sighting (70-100 whales) occurred in 1970 in Cape Cod Bay (Watkins and Schevill 1982).

Monitoring from shipboard surveys

Right whales are a critical species to be able to monitor. Shipboard monitoring is possible, but likely on dedicated surveys rather than on standardized surveys which monitor the entire northeast coastline. Estimates from our shipboard data 1980-1986 suggest a spring estimate of approximately 166 (best estimate) individuals. This is in the same range as estimates from individual identification techniques. Based on our surveys, right whales can be monitored during spring and summer (Table 35) in the south and southwest Gulf of Maine (Figure 19a, 19b).

Figure 19a. Distribution of all right whale sightings taken during shipboard surveys, for all seasons 1980-1986, in shelf waters of the northeastern United States.

Figure 19b. Distribution of all right whale sightings taken during shipboard surveys, by season, 1980-1986, in shelf waters of the northeastern United States.


76
65
RIGHT WHALE
(EUBALAENA GLACIALIS)
ALL SEASONS
LEGEND
SYMBOL SIZE
DENSITY PER TRANSECT
< 0.5
0.5 - 1.0
> 1.0
76
65

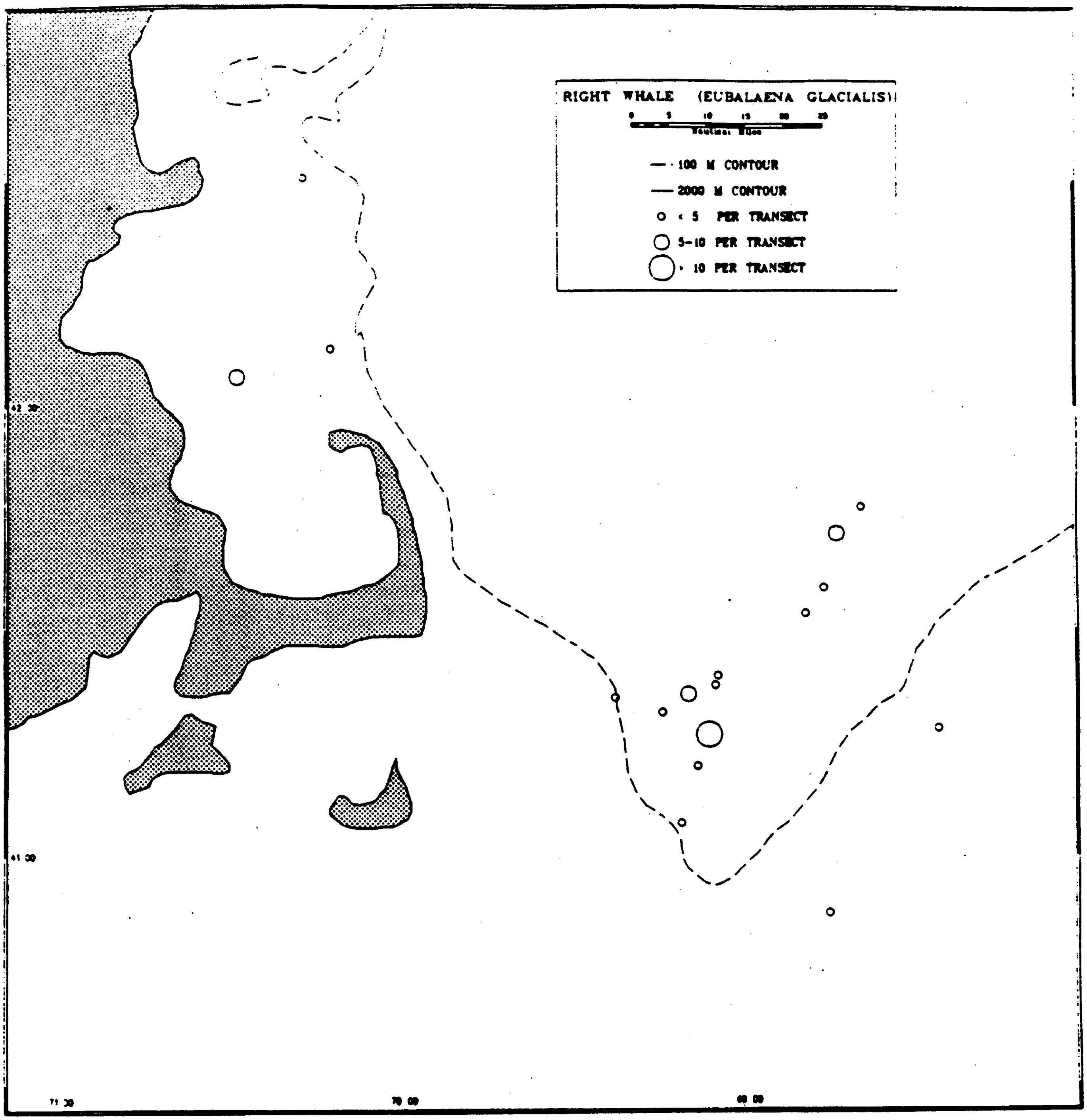

RIGHT WHALE (EUBALAENA GLACIALIS)
0 5 10 15 20 25
100 M CONTOUR
2000 M CONTOUR
< 5 PER TRANSECT
5-10 PER TRANSECT
> 10 PER TRANSECT
42 30
41 30
71 30
70 00
69 00

Table 35. Number of sightings, individuals and individuals/100 transects for right whales, 1980 through 1987, all data combined.

REGION	SUB-REGION	SPRING			SUMMER			AUTUMN			WINTER			ANNUAL TOTAL		
		SGHT-INGS	INDIV-IDUALS	IND'S PER - 100 TRANS	SGHT-INGS	INDIV-IDUALS	IND'S PER - 100 TRANS	SGHT-INGS	INDIV-IDUALS	IND'S PER - 100 TRANS	SGHT-INGS	INDIV-IDUALS	IND'S PER - 100 TRANS	SGHT-INGS	INDIV-IDUALS	IND'S PER - 100 TRANS
GULF OF MAINE	WEST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CENTRAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SOUTHWEST	5	12	6	0	0	0	1	1	0	0	0	0	6	13	2
	SOUTH	9	27	20	4	8	5	0	0	0	0	0	0	13	35	6
	TOTAL	14	39	6	4	8	1	1	1	0	0	0	0	19	48	2
GEORGES BANK	N. EDGE	1	2	3	0	0	0	0	0	0	0	0	0	1	2	1
	SHOALS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CENTRAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SHELF EDGE	1	1	1	0	0	0	0	0	0	0	0	0	1	1	0
	TOTAL	2	3	1	0	0	0	0	0	0	0	0	0	2	3	0
SOUTHERN NEW ENGLAND	INN. SHELF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	MID. SHELF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	OUT. SHELF	1	1	0	0	0	0	0	0	0	0	0	0	1	1	0
	TOTAL	1	1	0	0	0	0	0	0	0	0	0	0	1	1	0
MID-ATLANTIC BIGHT	INN. SHELF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	MID. SHELF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	OUT. SHELF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CAROL.CAPE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COASTAL ZONE	STRATUM 96	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	STRATUM 95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	STRATUM 94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CONTINENTAL SLOPE		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ALL REGIONS COMBINED		17	43	2	4	8	0	1	1	0	0	0	0	22	52	0

Ability of the Monitoring Program to Detect a Change in the Distribution of Cetaceans Within a Subregion and Between Regions.

1. SHIFTS IN THE DISTRIBUTION OF HUMPBACK AND FIN WHALES, 1982-1983, 1984-1985, AND 1986-1987, WITHIN THE SOUTH AND THE SOUTHWESTERN GULF OF MAINE, STRATA 23-27

During 1986 a decrease in the number of whales occurring on Stellwagen Bank and Jeffreys Ledge (NMFS strata 26-27) was observed (Mayo et al. 1987). The number of humpbacks in the region decreased to near zero during late summer 1986 and did not return to this area until summer 1987. This provides an opportunity to determine whether the monitoring program can detect shifts in distributions within a subregion and within a season. We examined the number of humpback whales/transect for each stratum 23-27 for each of the periods 1982-1983, 1984-1985 and 1986-1987 for apparent shifts in the numbers/effort of this whale species. We also examined the effect of a decrease in effort by looking for this shift using only the results from bottom trawl surveys, as well as the entire database.

The number of humpbacks per transect (in parentheses) indicate an increase in the number of whales occurring in Strata 23-35 since 1982 (all NMFS data, upper Table 36). There has also been a steady decline in the number per transect observed since 1982 in Strata 26-27. This is apparent in Figures 20c-20d as a cluster of sightings in the western portions of the Great South Channel in 1986 and a complete absence of sightings on Stellwagen Bank during this year.

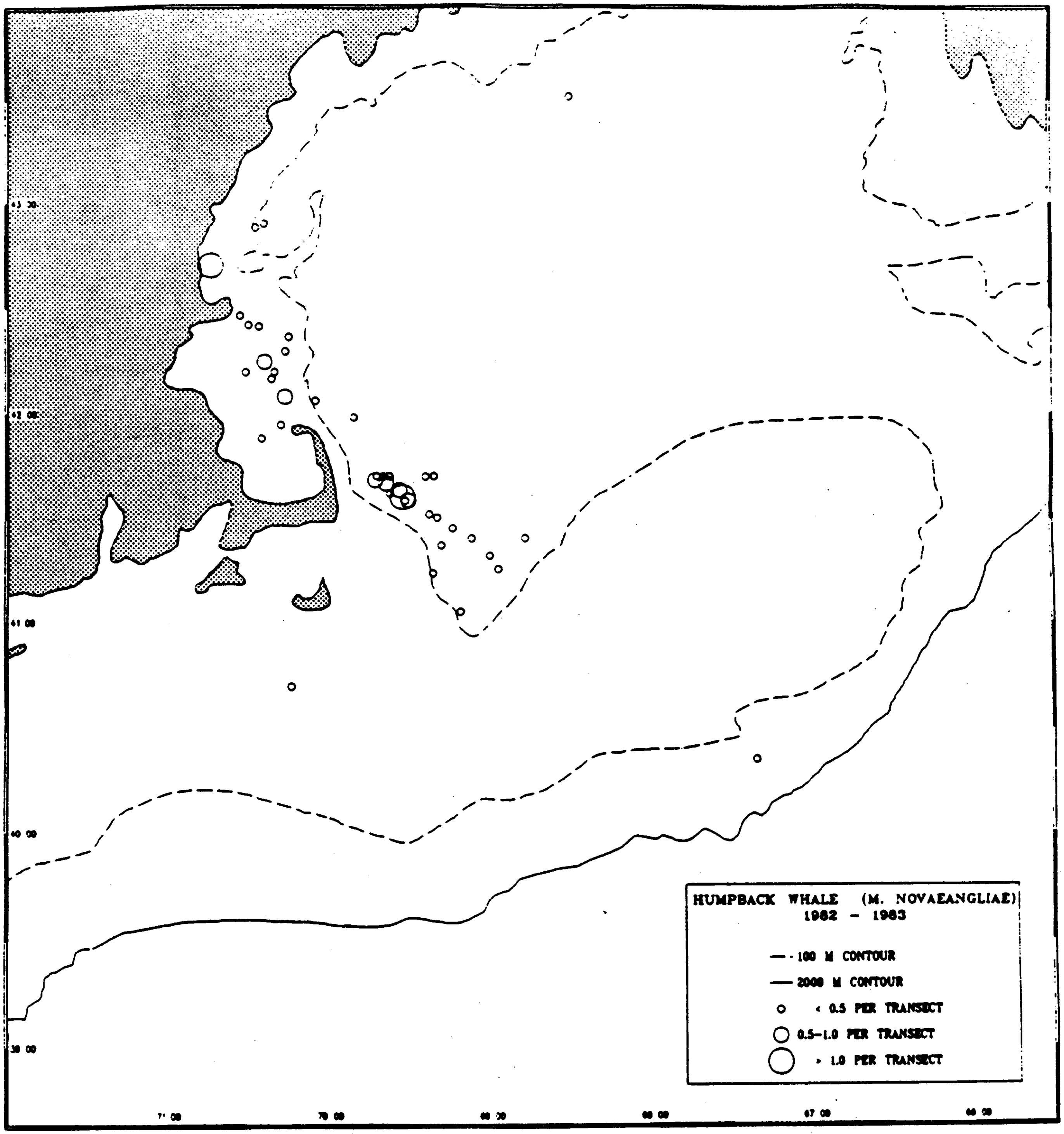
An increase in the number of whales in Strata 23,25 and a co-occurring decrease in the number of whales in Strata 26-27 can also be observed in the data when examining only sighting data collected during bottom trawl surveys (lower Table 36), although the numbers vary markedly.

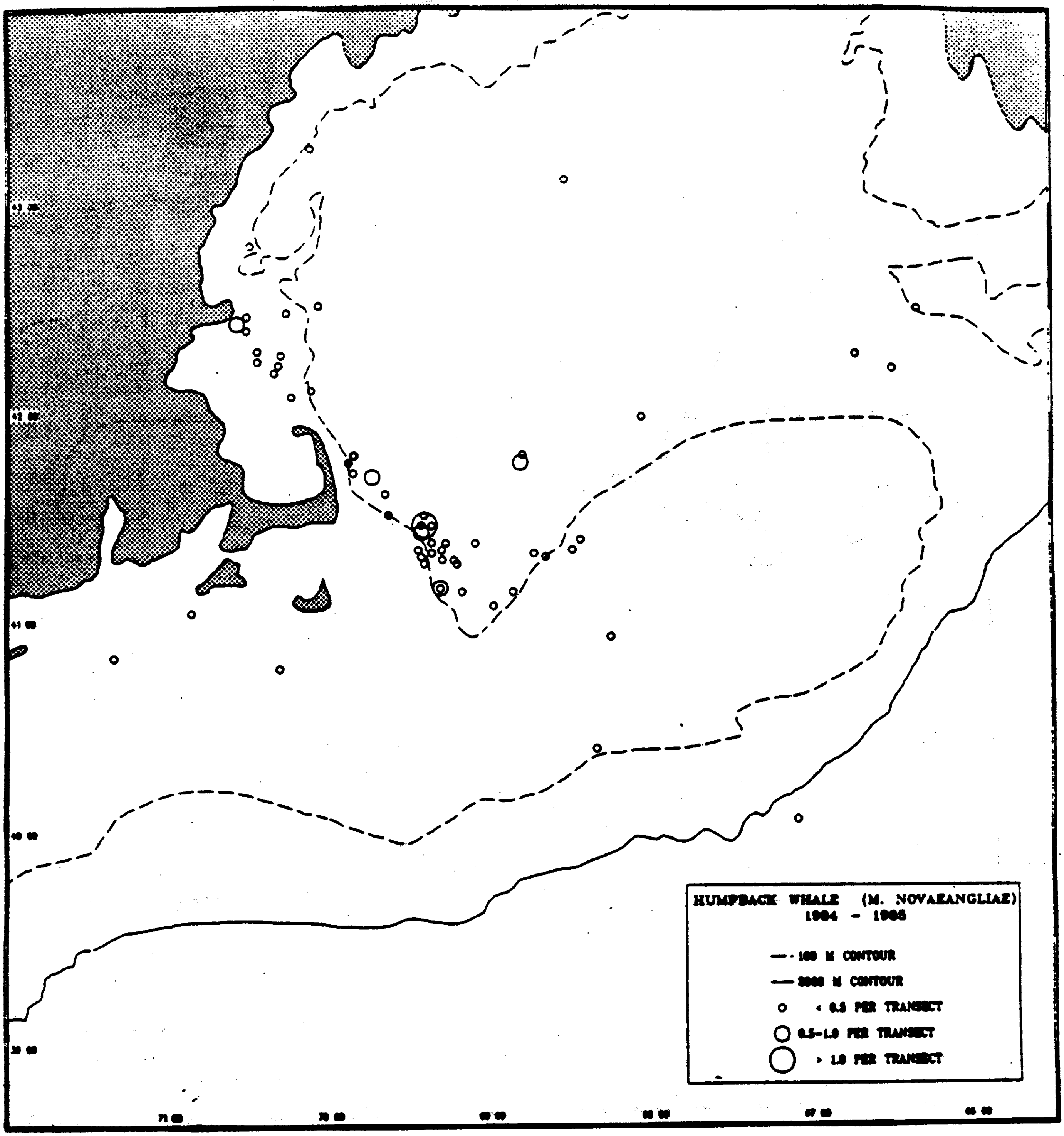
Figure 20a. Distribution of all humpback whale sightings taken during shipboard surveys, for all seasons 1982-1983, in shelf waters of the northeastern United States.

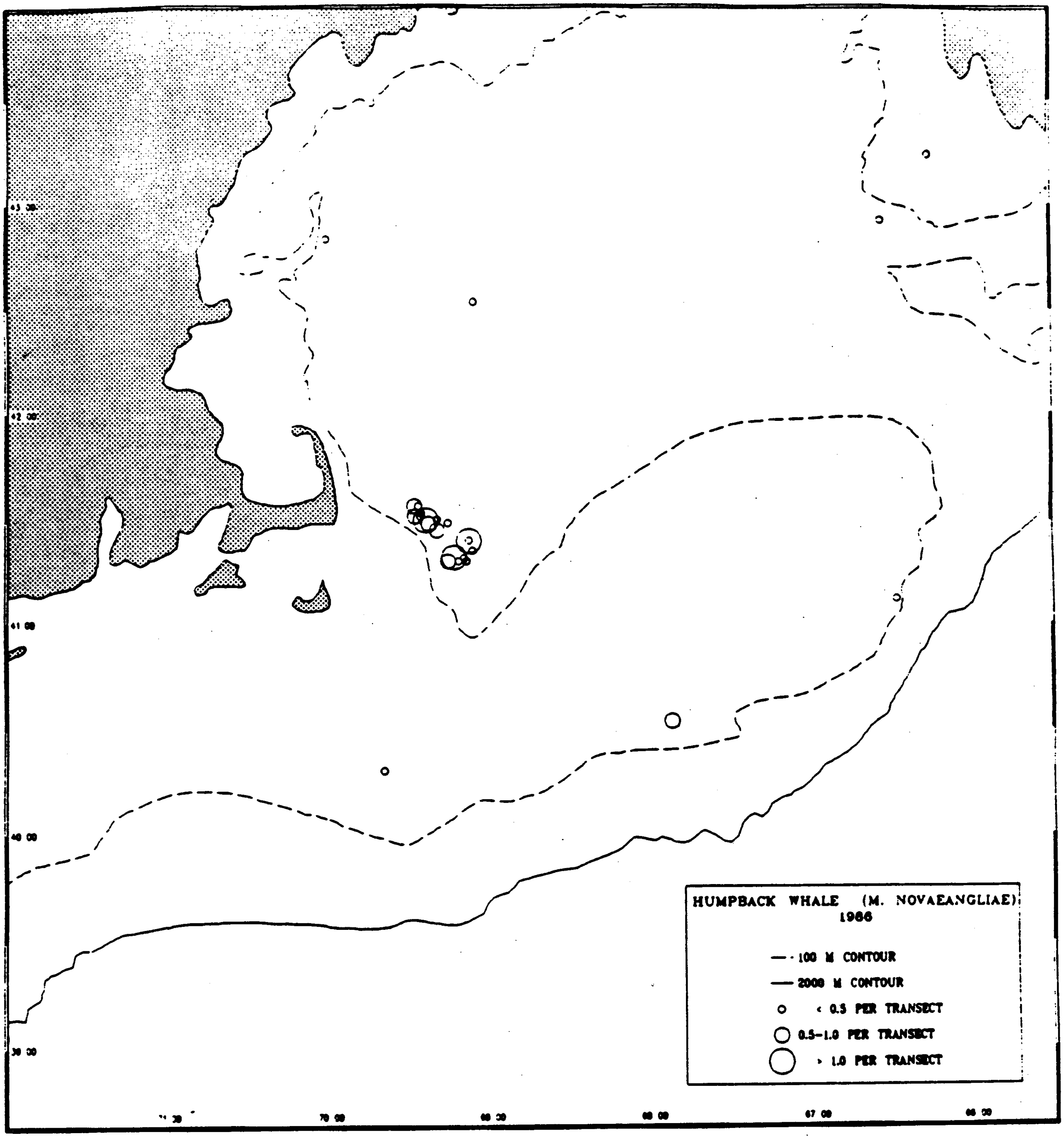
Figure 20b. Distribution of all humpback whale sightings taken during shipboard surveys, for all seasons 1984-1985, in shelf waters of the northeastern United States.

Figure 20c. Distribution of all humpback whale sightings taken during shipboard surveys, for all seasons 1986-1987, in shelf waters of the northeastern United States.

Figure 20d. Distribution of all humpback whale sightings taken during shipboard surveys, for all seasons, 1987, in shelf waters of the northeastern United States.


HUMPBACK WHALE (M. NOVAEANGLIAE)
1982 - 1983
100 M CONTOUR
2000 M CONTOUR
< 0.5 PER TRANSECT
0.5-1.0 PER TRANSECT
> 1.0 PER TRANSECT
67 00


HUMPBACK WHALE (M. NOVAEANGLIAE)
1984 - 1985
100 M CONTOUR
2000 M CONTOUR
< 0.5 PER TRANSECT
0.5-1.0 PER TRANSECT
> 1.0 PER TRANSECT


HUMPBACK WHALE (M. NOVAEANGLIAE)
1986
100 M CONTOUR
2000 M CONTOUR
< 0.5 PER TRANSECT
0.5-1.0 PER TRANSECT
> 1.0 PER TRANSECT
43 00
42 00
41 00
40 00
39 00
70 00
69 00
68 00
67 00
66 00

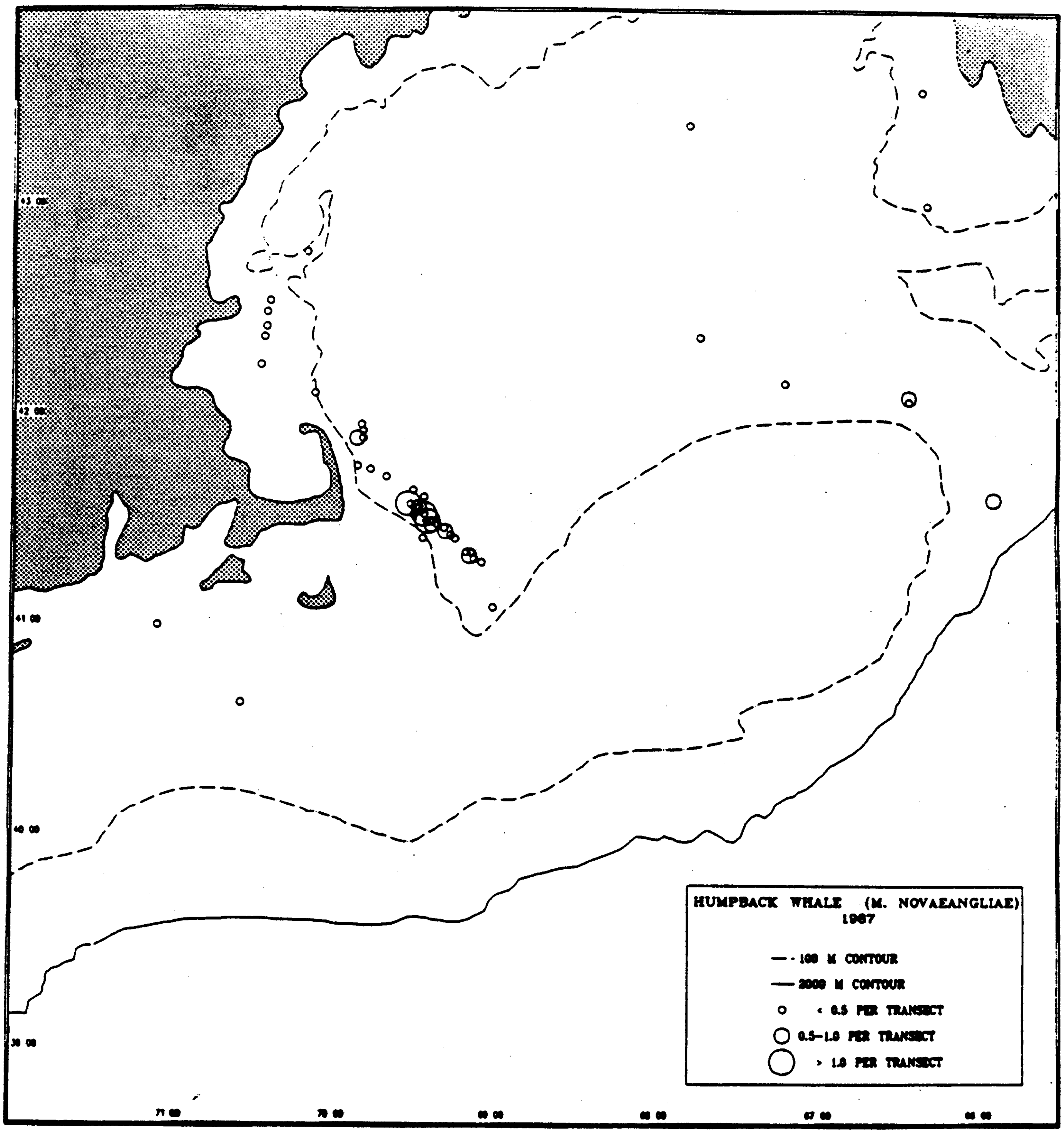

HUMPBACK WHALE (M. NOVAEANGLIAE)
1987
100 M CONTOUR
2000 M CONTOUR
< 0.5 PER TRANSECT
0.5–1.0 PER TRANSECT
> 1.0 PER TRANSECT
67 00

Table 36. Number of sightings per transect for humpback whales, 1982-1983, 1984-1985, 1986, and 1987, for NMFS subregions Southwest Gulf of Maine-northern section (Strata 26-27), Southwest Gulf of Maine-southern section (Strata 23,25), and the Gulf of Maine-South (Strata 24).

RESULTS FROM ALL NMFS SURVEYS, 1982-1987

YEAR	STRATA		
	23,25	24	26-27
1982-83	(0.17)	(0.10)	(0.28)
1983-85	(0.65)	(0.06)	(0.10)
1986-87	(1.36)	(0.20)	(0.15)

RESULTS FROM BOTTOM TRAWL SURVEYS ONLY, 1982-1987

YEAR	STRATA		
	23,25	24	26-27
1982-83	(0.36)	(0.04)	(0.27)
1983-85	(0.84)	(0.00)	(0.00)
1986-87	(3.00)	(0.00)	(0.00)

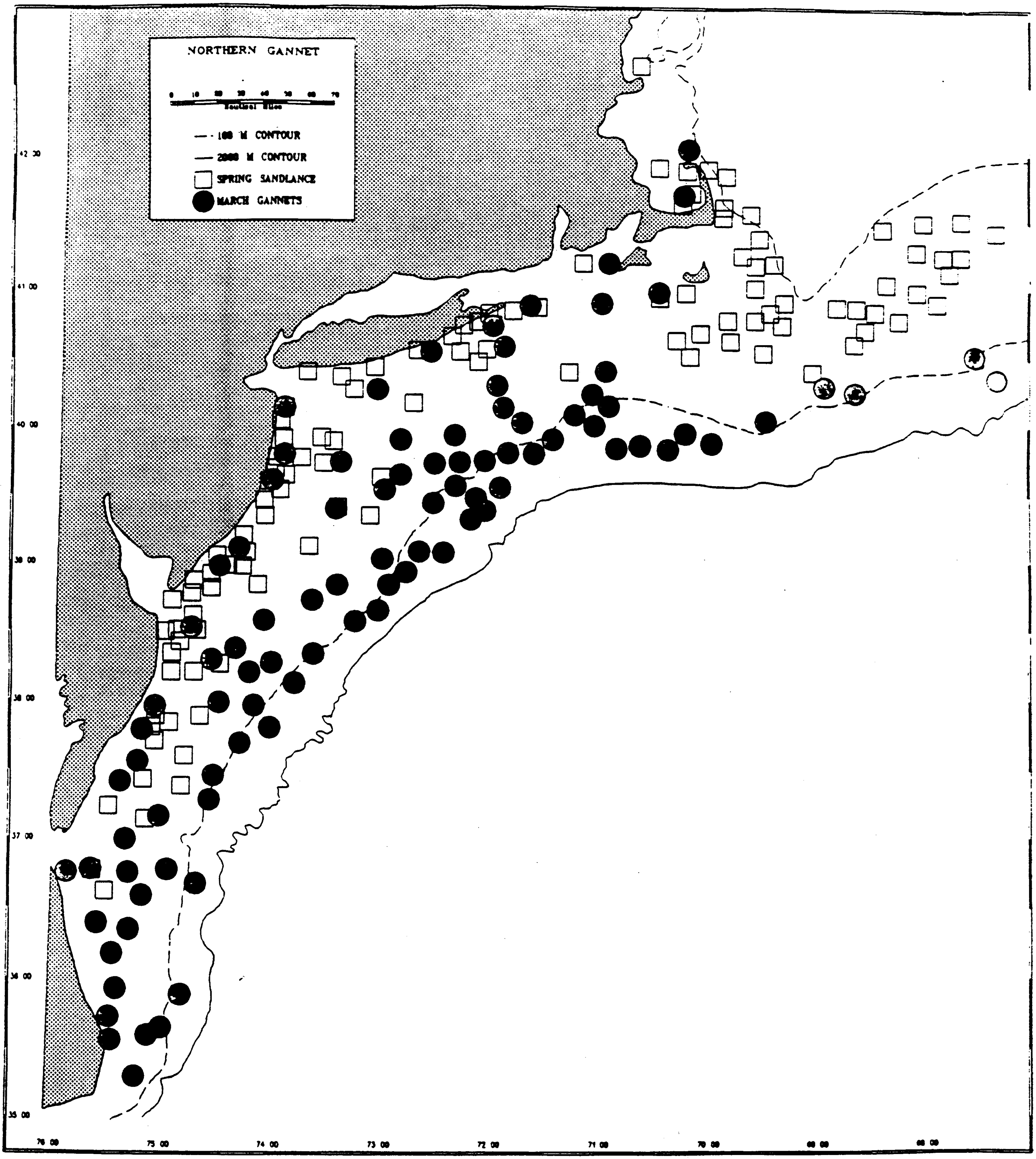
RECOMMENDATIONS FOR CONTINUED RESEARCH

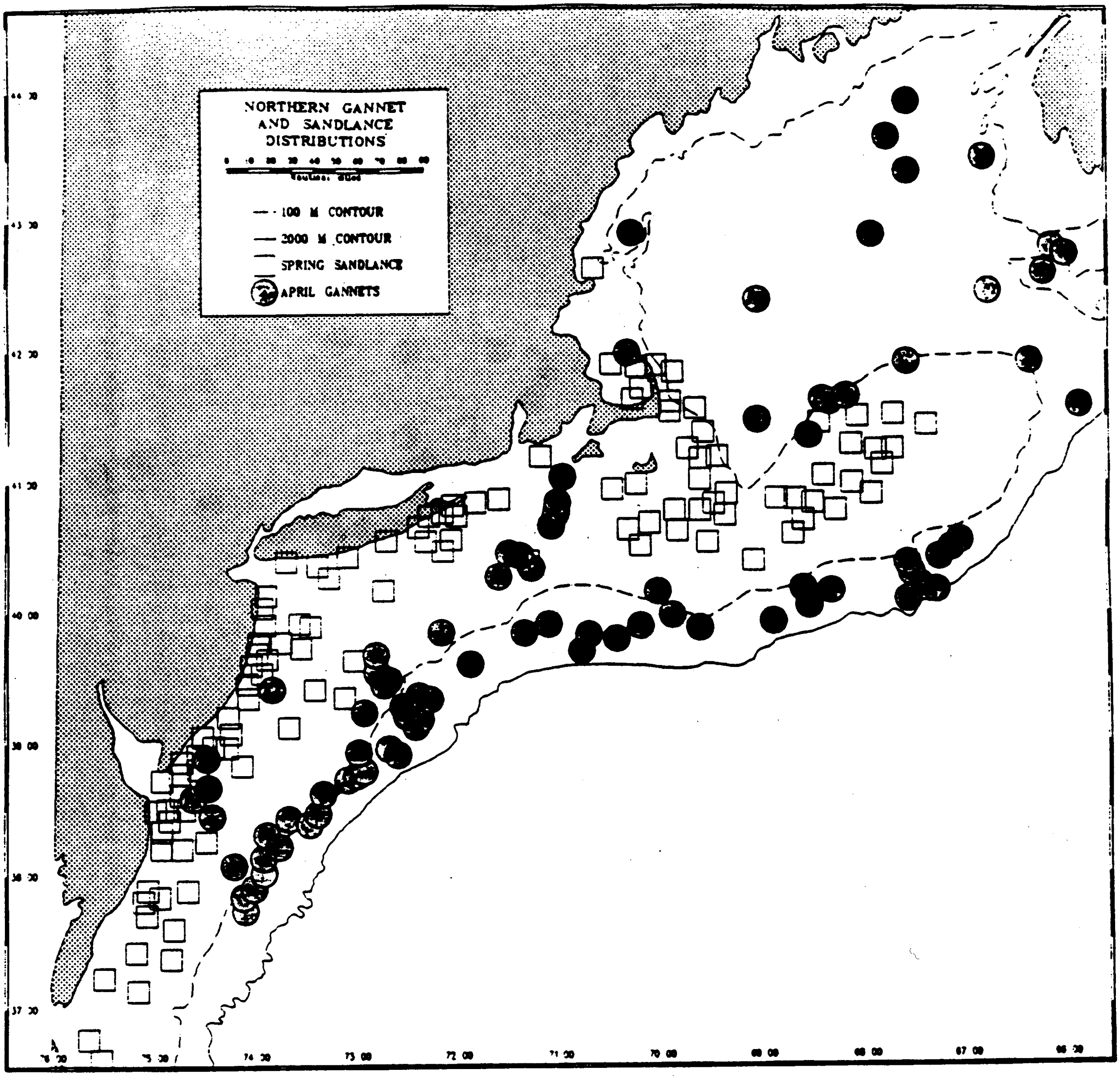
Data Analysis and Compatibility with Existing NMFS/NEFC Databases.

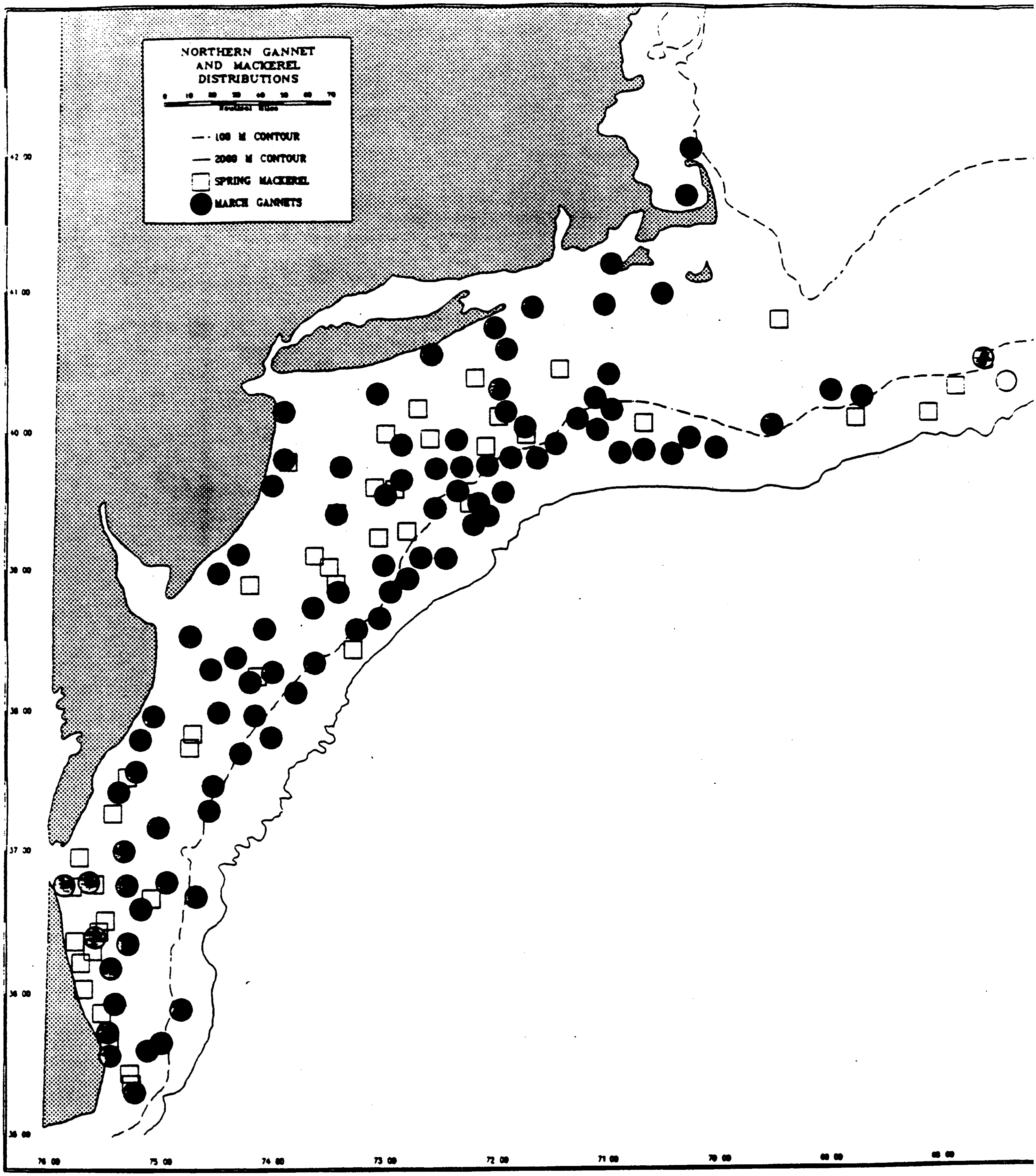
1. Compatibility with existing NMFS/NEFC Databases.

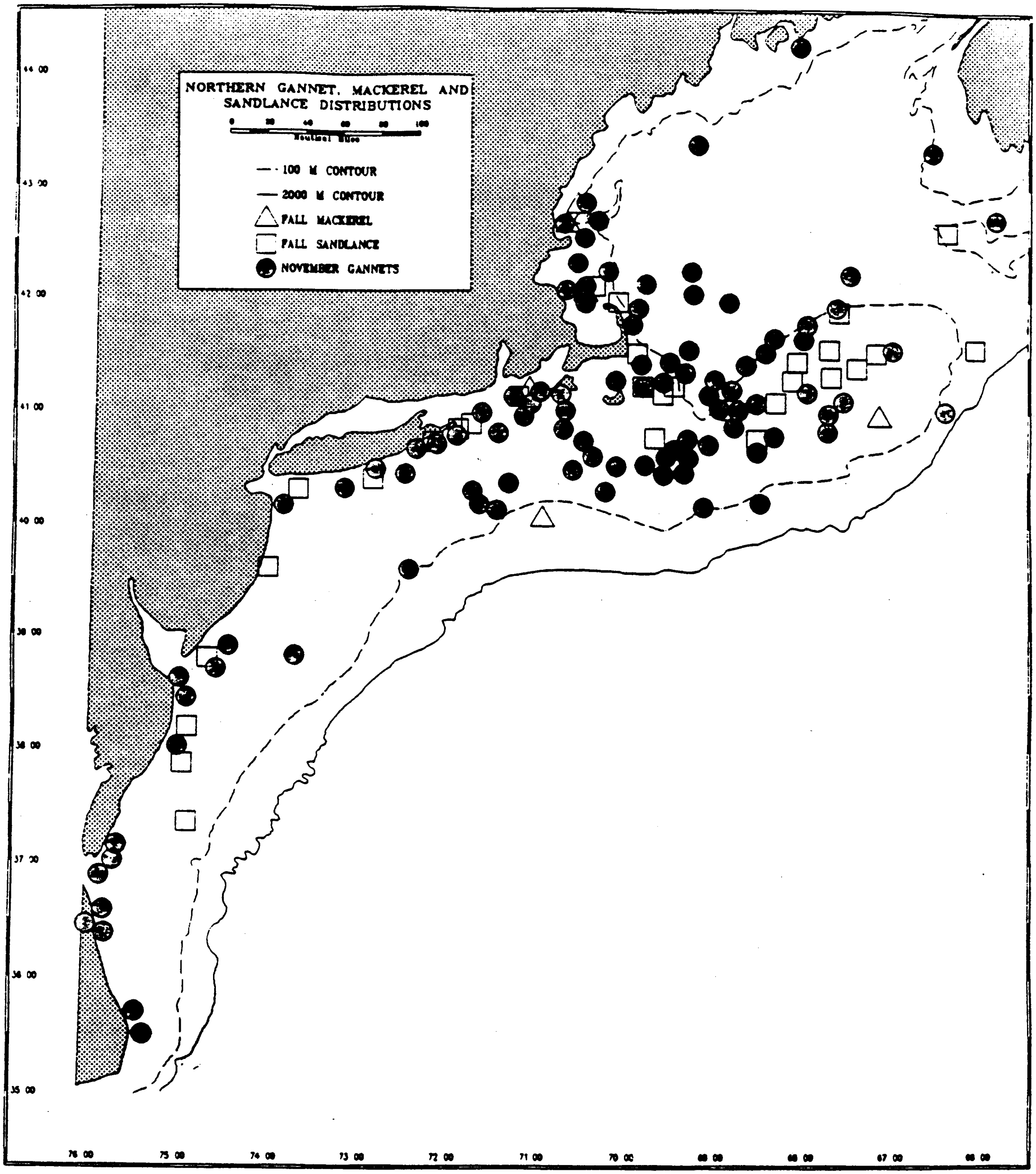
The survey design, method of stratification and timing of the surveys are completely congruent with those of the NMFS/NEFC. This program was designed in order that cetacean and seabird data could be directly compared with fisheries databases in a statistical manner.

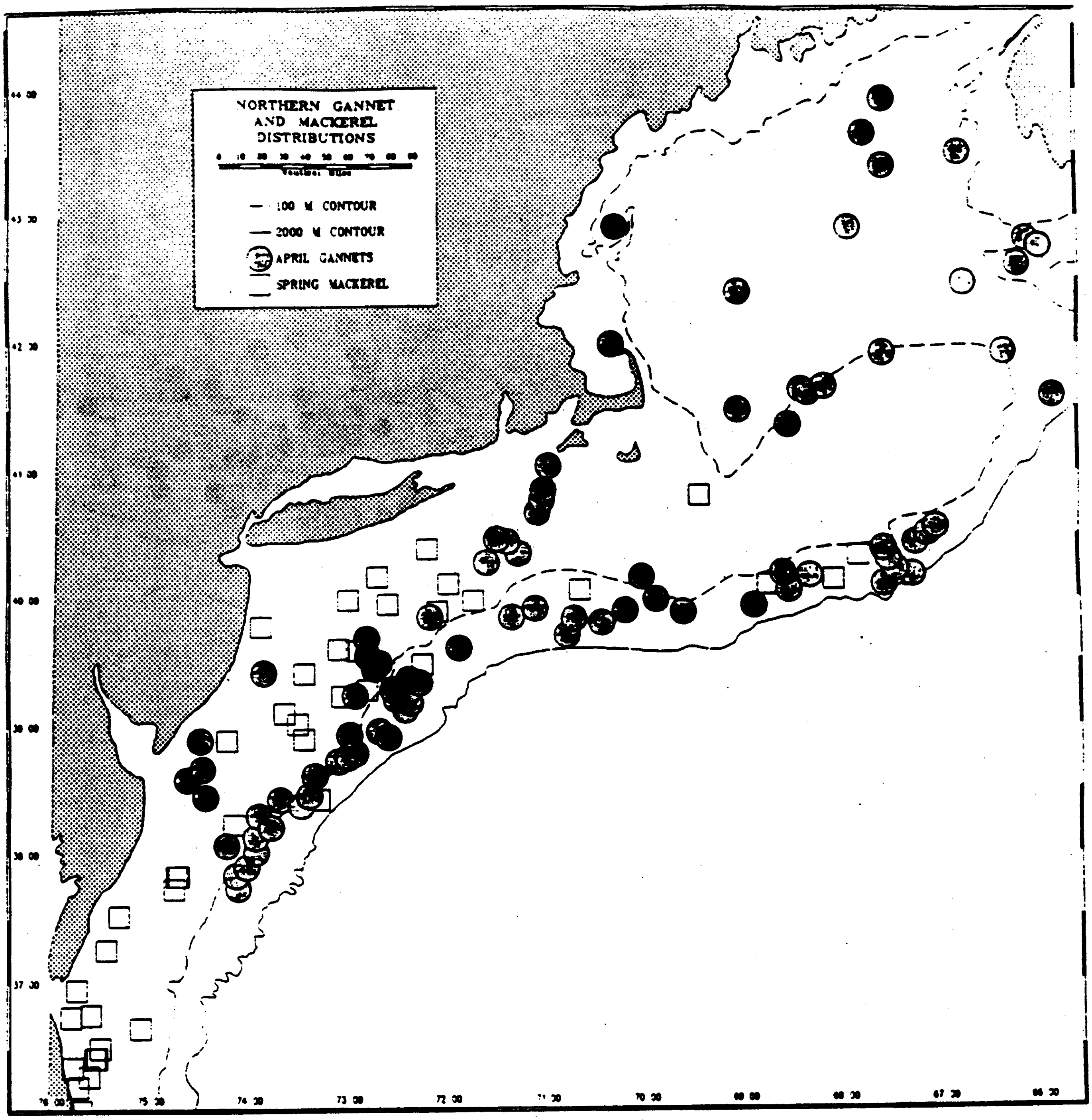
A preliminary examination of the database compatibility on broad scales was provided by Smith et al. (1988). This examination also provided MBO and NMFS with research needs which require further examination. For example, seasonal changes in the distribution of target speceies (cetaceans and seabirds) and that of potential prey species sampled during the NMFS traawl surveys can be compared on a broad scale through the cooccurrance of the species. Examples of this approach are provided in Figures 21a-21f. The distribution of March and April gannets Sula bassanus are compared with spring sandlance in Figures 21a-21b, and with spring mackerel Scomber scombrus in Figures 21c-21d. During March gannets are clustered in areas of sandlance and mackerel in the mid-Atlantic (Figures 21a, 21c). However, by April the distributions of gannets and sandlance segregate spatially across the shelf (Figure 21b). The distribution of gannets and mackerel are still clustered together along the mid-to outer shelf regions of southern New England and lower Georges Bank waters. It is apparent that the gannet relies more heavily on mackerel (rather than sandlance) as a prey species throughout its northward-spring migration. Conversely, during fall gannets and sandlance co-occur in the lower Gulf of Maine-Georges Bank regions (Figure 21e) indicating a predator-prey relationship. This co-occurance occurs in nearshore waters of the mid-Atlantic during early winter (Figure 21f). The abundance of mackerel

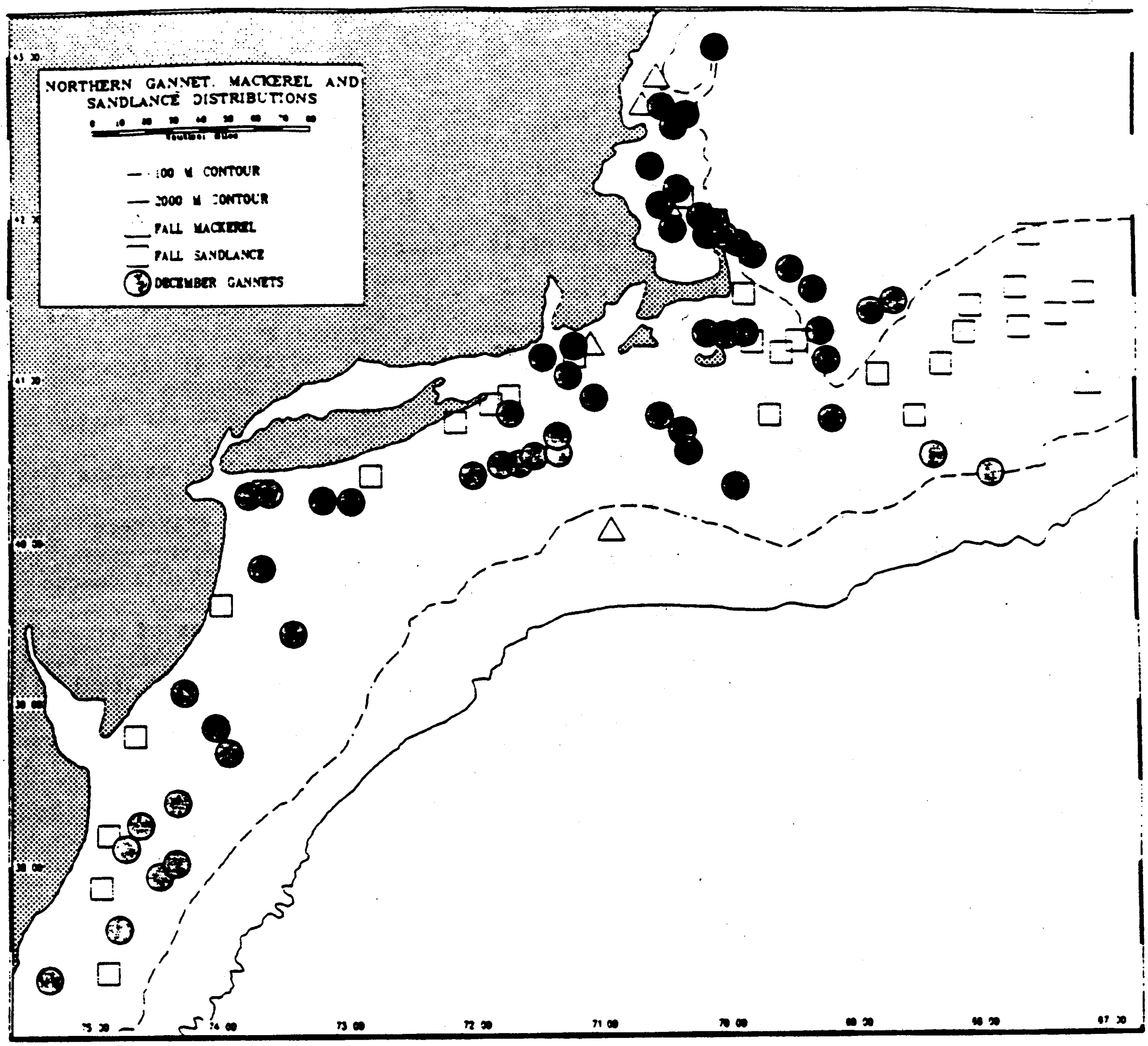

NORTHERN GANNET
100 M CONTOUR
2000 M CONTOUR
SPRING SANDLANCE
MARCH GANNETS
42 30
41 00
40 00
37 00
35 00
75 00
74 00
73 00
72 00
71 00
70 00


NORTHERN GANNET
AND SANDLANCE
DISTRIBUTIONS
100 M CONTOUR
2000 M CONTOUR
SPRING SANDLANCE
APRIL GANNETS


NORTHERN GANNET
AND MACKEREL
DISTRIBUTIONS
100 M CONTOUR
2000 M CONTOUR
SPRING MACKEREL
MARCH GANNETS


NORTHERN GANNET, MACKEREL AND SANDLANCE DISTRIBUTIONS
100 M CONTOUR
2000 M CONTOUR
FALL MACKEREL
FALL SANDLANCE
NOVEMBER GANNETS


NORTHERN GANNET
AND MACKEREL
DISTRIBUTIONS
100 M CONTOUR
2000 M CONTOUR
APRIL GANNETS
SPRING MACKEREL


NORTHERN GANNET, MACKEREL AND SANDLANCE DISTRIBUTIONS
100 M CONTOUR
2000 M CONTOUR
FALL MACKEREL
FALL SANDLANCE
DECEMBER GANNETS
75 30
74 00
73 00
72 30
71 00
70 00
68 30
67 30

on shelf waters at this time is low. Therefore, it is unlikely that mackerel is as important to gannets in fall as in spring, and sandlance are more important throughout fall and possibly early winter.

A similar, fine scale examination of the distribution of humpback whales and sandlance (at the strata level) has been previously provided by Payne et al (1986) and data in this report. Another approach is to tabulate for every cetacean or seabird sighting the frequency with which other finfish species were caught when fishery survey stations at increasing distances away were sampled. Smith et al. (1988) provided these comparative statistics for common and whitesided dolphins and humpback and fin whales and five species of finfish and squid. This example joint analysis of the data from otter-trawl surveys and the cetacean and seabird sighting surveys provided by Smith et al. (1988) suggest that very fine scale retlationships describing trophic interactions between cetaceans/seabirds and pelagic fishes may be evaluated using these techniques and this survey format. The results of the sighting surveys during fishery surveys provide results similar to those available from other sampling approaches (Hain et. al. 1981; CeTap 1982; Kenney et al. 1985) at a much lower cost than other platforms. Most importantly the compatibility of the sighting databases with the NMFS fishery/oceanographic database provide statitstical comparisons not available from other platforms. Environmental variables collected simultaneous with sighting data can also be compared directly to the observed distrbitutional data to determine the effects of environmental variables on the distribution of cetaceans, and more generally seabirds. An example of this compatibility and type of analysis was provided by Selzer and Payne (1988).

2. <u>Demonstrated Ability to Monitor Trends in Cetacean Distribution and Patterns of Abundance.</u>

The survey data do monitor trends in abundance and distribution. This is apparent by comparing data from these surveys to previous datasets (i.e. Cetap 1982) and by examining trends and shifts in key cetacean species since 1980. It is, however, also apparent that with the recent decreases in survey time by NMFS and the restrictions placed on observer coverage aboard available trawl surveys, it is unlikely that a large-scale monitoring (i.e. the entire study area) can continue under present survey restrictions. A monitoring of the key areas for baleen whales (lower Gulf of Maine, Georges Bank) might continue to provide compatible data which will monitor a large percentage of the whales throughout the study area. It is unlikely that dolphins could be monitored without survey coverage in the mid-Atlantic.

Throughout these analyses we have examined abundance indices by only looking at numbers per transect, rather than densities and absolute estimates of abundance. This is an immediate focus of the CSAP personnel, but it seemed more relevant to discuss the current and immediate problems with the decrease in survey effort at this time. Abundance estimates from line-transect procedures (i.e. SURVEY software) and outstanding status reviews relevant to NMFS immediate needs are a high priority and will be provided in an intermim report, six months prior to the end of the first contract year. During the next six months it is also hoped that the CSAP dataset can be combined with the CeTAP dataset and an atlas focusing on the distribution of cetacean in our study area (between 1978-1988) will be finalized. A redefinition of cetacean high-use areas in relation to fisheries, trophic interactions between cetacean and fish/plankton species, and status of marine mammals relevant to incidental take will be emphasized in light of decreased survey effort and increased NMFS demands relevant to marine mammals/fisheries and current revisions to the Marine Mammal Protection Act.

LITERATURE CITED

Balcomb, K. C. and G. Nichols. 1978. Western North Atlantic humpback whales. Rep. Int. Whal. Comm. 28:159-164.

Burnham, K. P., D. R. Anderson, and J. F. Laake. 1980. Estimation of density from line transect sampling of biological populations. Wildl. Monogr. No. 72. 202 pp.

Caldwell, D. K., M. C. Caldwell, W. F. Rathjen, and J. R. Sullivan. 1971. Cetaceans from the Lesser Antillean Island of St. Vincent. Fish. Bull. 69:303-312.

Caldwell, D. K. and M. C. Caldwell. 1975. Dolphin and small-whale fisheries of the Caribbean. J. Fish. Res. Bd. Canada 32:1105-1110.

CeTAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf. Final Report of the Cetacean and Turtle Assessment Program, Bureau of Land Management, Contract No. AA551-CT8-48, U.S. Dept. of Interior, Wash. DC. 450 pp.

Eberhardt, L. L. 1978. Transect methods for population studies. J. Wildl. Manage. 42:1-31.

Eberhardt, L. L., D. G. Chapman, and J. R. Gilbert. 1979. A review of marine mammal census methods. Wildl. Monogr. No. 63. 46 pp.

Fritts, T. H. and R. P. Reynolds. 1981. Pilot study of the marine mammals, birds and turtles in OCS areas of the Gulf of Mexico. U. S. Fish and Wildl. Serv., Office of Biological Services, Washington, DC. FWS/OBS-81/36.

Gaskin, D. E. 1977. Harbour porpoise _Phocoena phocoena_ (L.) in the western approaches to the Bay of Fundy 1969-75. Rep. Int. Whal. Comm. 27:487-492.

Grosslein, M. D. 1969. Groundfish survey programs of BCF Woods Hole. Comm. Fish. Rev. 31:22-35.

Hain, J. H., M.A.M. Hyman, R. D. Kenney and H. E. Winn. 1985. The role of cetaceans in the shelf edge region of the western North Atlantic. Mar. Fish. Rev., 47: 13-17.

Kapel, F. O. 1975. Preliminary notes on the occurrence and exploitation of smaller cetacea in Greenland. J. Fish. Res. Bd. Canada 32:1079-1082.

Katona, S., W. Steiner, and H. E. Winn. 1977. Marine Mammals. Pp. 1-167, _In_ Center for Natural Areas, A summary and analysis of environmental information on the Continental Shelf from the Bay of Fundy to Cape Hatteras, 1977, Vol. 1, Book 2. Final Rept., Contr. No. AA550-CT6-45, Bureau of Land Mgmt., U.S. Dept. of Interior.

Katona, S. K., V. Rough and D. T. Richardson. 1983. A Field Guide to the Whales, Porpoises and Seals of the Gulf of Maine and eastern Canada -- Cape Cod to Newfoundland.

Katona, S. K., J. A. Beard and K. C. Balcomb, III. 1984. The humpback whale fluke catalogue. Final Rept. to NMFS Contract No. NA-81-FA-C-00027.

Kenney, R. D., D. R. Goodale, G. P. Scott, and H. E. Winn. 1981. Spatial and temporal distribution of Humpback Whales in the CETAP study area. In A characterization of marine mammals and turtles in the Mid- and North Atlantic areas of the U.S. outer continental shelf. Ann. Rept. 1979, CETAP Program, Univ. of Rhode Island. Prepared for Bureau of Land Mgmt, U.S. Dept. of Interior, Washington, DC.

Kenney, R. D., M. A. M. Hyman, and H. E. Winn. 1985. Calculations of standing stocks and energetic requirements of the cetaceans of the northeast United States outer continental shelf. NOAA Tech. Memo. NMFS-F/NEC-41. 99 pp.

Kenney, R. D. and H. E. Winn. 1986. Cetacean high-use habitats of the northeast U. S. continental shelf/slope areas. Fish. Bull., 84: 345-357.

Kenney, R. D. and H. E. Winn. 1987. Cetacean biomass densities near submarine canyuons compared to adjacent shelf/slope areas. Cont. Shelf Res., 7: 107-114.

Kraus, S. D. 1985. A review of the status of right whales (Eubalaena glacialis) in the western North Atlantic with a summary of research and management needs. Final report, contract no. MM2910905. U.S. Marine Mammal Commission, Washington, DC.

Kraus, S. D. Black right whale (Eubalaena glacialis). In T. French (ed.). Endangered, Threatened and Special Concern Vertebrate Species in Massachusetts. Mass. Div., Fish & Wildlife, Non-game and Endangered Species Program. Boston, MA 02202 (in press).

Kraus, S. D. and J. H. Prescott. 1981. Distribution, abundance and notes of the large cetaceans of the Bay of Fundy, summer and fall 1980. Final Rept. to NMFS/NEFC, Contract No. NA-80-FA-2-00048.

Kraus, S. D., J. H. Prescott and G. S. Stone. 1984. Right whales (Eubalaena glacialis) in the western North Atlantic: A summary of research conducted from 1980 to 1984. Report to NMFS/NEFC, Contract No. NA-81:FA-C88830, Woods Hole, MA 02543.

Leatherwood, S., D. K. Caldwell, and H. E. Winn. 1976. Whales, dolphins, and porpoises of the western North Atlantic. A guide to their identification. U.S. Dept. Commerce., NOAA Tech. Rept. NMFS Circ. 396. 176 pp.

Mayo, C. A. 1982. Observations of cetaceans: Cape Cod Bay and Southern Stellwagen Bank, Massachusetts 1975-1979. NTIS Report No. PB82-186263. 68 pp.

Mayo, C. A., C.A. Carlson, and M. K. Gilmore. 1985. Food and feeding of right whales on Cape Cod Bay, Massachusetts. Presented at the Sixth Biennial Conference on the Biology of Marine Mammals, Vancouver, B.C., Nov. 22-26, 1985.

Mayo, C. A., D. K. Mattila, S. Pittman, P. Christian, and L. Baraff. 1988. Abundance, distribution and habitat use of large whales in the southern Gulf of Maine, May 1-September 30, 1986. Interim Contract Report #50-EANF-6-00059 to NMFS/NEFC, Woods Hole, MA .

Mead, J. G. 1975. Distribution of cetaceans along the Atlantic and Gulf coasts of the United States. Unpubl. ms. submitted to Marine Mammal Comm. MMC MM4AC007.

Mercer, M. S. 1975. Modified Leslie-DeLury population models of the the long-finned pilot whale (Globicephala melaena) and annual production of the short-finned squid (Illex illecebrosus) based upon their interaction at Newfoundland. J. Fish. Res. Bd. Canada 32:1145-1154.

Mitchell, E. 1975a. Porpoise, dolphin and small whale fisheries of the world. Status and problems. Int. Union Cons. Nat. Resource Monogr. No. 3, 129 pp.

Mitchell, E. 1975b. Preliminary Report on Nova Scotia fishery for Sperm Whales (Physeter catadon). Rept. Int. Whal. Comm. 25:226-235.

Mitchell, E. and D. G. Chapman. 1977. Preliminary Assessment of Stocks of Northwest Atlantic Sei Whales (Balaenoptera borealis). In Report of the Special Meeting of the Scientific Committee on Sei and Bryde's Whales. Rept. Int. Whal. Comm. Special Issue 1:117-120, Cambridge.

Mitchell, E. and V. M. Kozicki. 1984. Reproductive condition of male sperm whales, Physeter macrocephalus, taken off Nova Scotia. Reports of the International Whaling Commission, Special Issue 6:243-252.

Neave, D. J., and B. S. Wright. 1968. Seasonal migrations of the Harbor Porpoise (Phocoena phocoena) and other Cetacea in the Bay of Fundy. J. Mamm. 49:259-264.

Payne, P. M., K. D. Powers, and J. E. Bird. 1983. Opportunistic feeding on whale fat by Wilson's Storm-Petrels Oceanites oceanicus in the western North Atlantic. Wils. Bull. 95:478-479.

Payne, P. M., L. A. Selzer, and A. T. Knowlton. 1984. Distribution and density of cetaceans, marine turtles and seabirds in the shelf waters of the northeastern United States. June 1980 - Dec. 1983, from shipboard observations. NMFS/NEFC Contr. No. NA-81-FA-C-00023. 246 pp.

Payne, P. M., J. R. Nicolas, L. O'Brien, and K. D. Powers. 1986. Distribution of the humpback whale (Megaptera novaeangliae) on Georges Bank and in the Gulf of Maine in relation to densities of the sand eel (Ammodytes americanus). Fish. Bull: in press.

Powers, K. D. 1982. A comparison of two methods of counting birds at sea. J. Field Ornith. 53:209-222.

Powers, K. D. 1983. Pelagic distributions of marine birds off the north-eastern United States. NOAA Tech. Memorandum NMFS-F/NEC-27. Woods Hole, MA. 199 pp.

Powers, K. D. 1987. Biological Oceanographyt-Seabirds, pp. 194-202 In J. D. Miliman and W. R. Wright (Eds.) The Marine Environment of the U. S. Atlantic Continental Slope and Rise. Jones and Bartlett Publ., Inc., Boston, Ma.

Powers, K. D., and E. H. Backus. 1988. Estimates of consumption by seabirds on Georges Bank. pp. 372-374, In R. H. Backus (ed.) Georges Bank and its surroundings. MIT Press, Cambridge, MA 02139.

Powers, K. D., and R. G. B. Brown. 1988. Bird life on Georges Bank. pp. 359-371, In R. H. Backus (ed.) Georges Bank and its surroundings: book and atlas. MIT Press, Cambridge, MA 02139.

Powers, K. D., and P. M. Payne. 1983. Distribution of marine mammals, birds and turtles near the Deepwater Dumpsite 106 (DWD-106) and the Philadelphia Dumpsite (PDS). In J. B. Pearce et al. (eds.) Northeast Monitoring Program, 106-Mile Site Characterization Update, NOAA Tech. Mem. NMFS-F/NEC-26, Chap. 11.

Powers, K. D., P. M. Payne, and D. S. Miller. 1980. A marine observer training program. Final Rept. to NMFS/NEFC, Contract No. NA80-FA-D-0004, Woods Hole, MA. 73 pp.

Prescott, J. H., and P. M. Fiorelli. 1980. Review of the harbor porpoise (Phocoena phocoena) in the U.S. Northwest Atlantic. Final Rept. to Marine Mamm. Commission Contract No. MM8AC016, NTIS PB80-176928. 55 pp.

Reeves, R. R., J. G. Mead, and S. Katona. 1978. The right whale, Eubalaena glacialis in the western North Atlantic. Rep. Int. Whal. Comm. 28:303-312.

Saemundsson, B. 1939. Zoology of Iceland. Muntsgaard. Copenhagen.

Schmidly, D. J. 1981. Marine mammals of the southeastern United States coast and the Gulf of Mexico. U.S. Fish and Wildl. Service, Biol. Serv. Progr. FWS/OBS-80/41.

Scott, G. P., R. D. Kenney, T. J. Thompson, and H. E. Winn. 1983. Functional roles and ecological impacts of the cetacean community in the waters of the northeastern U.S. continental shelf. Int. Cons. Explor. Sea., C.M. 1983/N:12.

Seber, G. A. F. 1973. The estimation of animal abundance. Hafner Publ. Co., Inc. New York. 506 pp.

Selzer, L. A. and P. M. Payne. 1988. The distribution of whitesided (Lagenorhynchus acutus) and common dolphins (Delphinus delphis) versus environmental features of the continental shelf of the northeastern United States. Mar. Mamm. Sci., 4: 141-153.

Sergeant, D. E. 1968. Sightings of marine mammals. Int., Comm. Northw. Atl. Fish. Spec. Publ. No. 7:241-244.

Sergeant, D. E., and H. D. Fisher. 1957. The Smaller Cetacea of Eastern Canadian Waters. J. Fish. Res. Bd. Can. 14:83-115.

Sergeant, D. E., A. W. Mansfield, and B. Beck. 1970. Inshore records of Cetacea for eastern Canada, 1949-1968. J. Fish. Res. Bd. Can. 27: 1903-1915.

Sherman, K. C. 1980. MARMAP, a fisheries ecosystem study in the northwest Atlantic: fluctuations in ichthyoplankton-zooplankton components and their potential for impact on the system.

Sissenwine, M. P., W. J. Overholtz, and S. H. Clark. 1983. In search of density dependence. Pp. 119-138 In B. R. Melteff (ed.) Proceedings of the workshop on Marine Mammal Fishery - Interactions of the east Bering Sea. Univ. of Alaska Sea Grant, Fairbanks, AK. 300 pp.

Smith, T., P. M. Payne, D. Heinemann, G. Waring and A. Lange. 1988. Utility of cetacean ans seabird sighting surveys conducted during fishery surveys. ICES, C. M. 1988/N:L 5. 40 pp.

Sutcliffe, W. H., and P. F. Brodie. 1977. Whale distributions on Nova Scotia Waters Fisheries and Marine Service Technical Report No. 722. Fisheries and Marine Service, Bedford Institute of Oceanography, Dartmouth, Nova Scotia. 83 pp.

Tasker, M. L., P. Hope-Jones, T. Dixon, and B. F. Blake. 1984. Counting seabirds at sea from ships: a review of methods employed and suggestion for a standardized approach. Auk 101:567-577.

Watkins, W. A. and W. E. Schevill. 1976. Right whale feeding and baleen rattle. J. Mammal. 57:58-66.

Watkins, W. A. and W. E. Schevill. 1982. Observations of right whales, Eubalaena glacialis, in Cape Cod waters. Fishery Bulletin 80:875-880.

Wenzel, F., D. K. Mattila and P. J. Clapham. 1988. The first sighting of blue whales Balaenoptera musculus in the Gulf of Maine. Mar. Mamm. Sci. 4: 172-175.

Whitehead, H. and M. J. Moore. 1982. Distribution and movements of West Indian humpback whales in winter. Can. J. Zool. 60:2203-2211.

Whitehead, H., R. Silver, and P. Harcourt. 1982. The migration of humpback whales along the northeast coast of Newfoundland. Can. J. Zool. 60:2173-2179.

Whitehead, H., and C. Glass. 1985. The significance of the southeast Shoal of the Grand Bank to humpback whales and other cetacean species. Can. J. Zool. 63:2617-2625.

Wiens, J.A., D. Heinemann and W. Hofmann. 1978. Community structure, distribution, and interrelationships of marine birds in the Gulf of Alaska. In Environmental Assessment of the Alaskan Continental Shelf, Final Reports to Biological Studies 3: 1-178. U. S. Dept of Commerce, National Oceanographic and Atmospheric Administration.

Winn, H. E., R. K. Edel, and A. G. Taruski. 1975. Population estimates of the humpback whale (Megaptera novaeangliae) in the West Indies by visual and acoustic techniques. J. Fish. Res. Rd. Can. 32:499-506.

Winn, H. E., P. W. Sorenson, and C. A. Price. 1984. The distributional biology of the right whale, Eubalaena glacialis, from Cape Hatteras to Nova Scotia. Draft Final Rept., Contract No. 14-12-0001-30091. Min. Mgmt. Serv., U.S. Dept. of the Interior, Washington, DC.